



**INDEX OF LEADING
ENVIRONMENTAL
INDICATORS**

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STEVEN F. HAYWARD





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Thirteenth Edition

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—Steven F. Hayward

"If there is one country that bears the most responsibility for the lack of progress on international environmental issues, it is the United States."

—Gus Speth, *Red Sky at Dawn*

"Sadly, our nation is also at present the biggest engine of ecological destruction on Earth, the chief (but by no means only) force keeping humanity on a collision course with the natural world."

—Paul and Anne Ehrlich, *One with Nineveh*

U.S. GIVEN POOR MARKS ON THE ENVIRONMENT

—*New York Times* headline, January 23, 2008

Preface

INTRODUCING THE INDEX OF LEADING ENVIRONMENTAL INDICATORS VERSION 2.0

To borrow the blunt language of Generation X and the “Millennials,” *Does the United States suck on the environment?* This 13th edition of the *Index of Leading Environmental Indicators* aims to address this question in a new and broader context. Contrary to the perception expressed in the epigraphs above, the answer turns out to be a resounding *no*; the United States remains the world’s environmental leader, and is likely to continue as such. This edition of the *Index* will explain and quantify this heterodox conclusion.

As this report and others like it have explored for more than a decade, environmental improvement in the United States has been substantial and dramatic, almost across the board. The chief drivers of this improvement are economic growth, constantly increasing resource efficiency, technological innovation in pollution control, and the deepening of environmental values among the American public. Government regulation has played a central role, to be sure, but in the grand scheme

of things it is a lagging indicator of change, and often achieves results at needlessly high cost. Were it not for rising affluence and technological innovation, regulation would have much the same effect as King Canute commanding the tides.

But in a variation of the old complaint “What have you done for me lately?” there is a widespread perception that the United States lags behind Europe and other leading nations on environmental performance. This perception is even more strongly held abroad than here in the United States.

Yale University’s professor Daniel Esty, chief author of the World Economic Forum’s very useful *Environmental Performance Index (EPI)*, a new iteration of which appeared in January of this year, notes an interesting irony on this point. In the *EPI*’s 2005 ranking of 133 nations, the United States placed 28th, based on the study’s comparison of 16 key indicators. When he presents these findings in

the United States, Professor Esty reports, audiences often ask how it is that the United States scores so *poorly*. Americans, after all, are used to appearing at or near the very top of all international rankings of good things.

In Europe, Professor Esty says, audiences wonder how it is possible that the United States scores so *high*. Surely there must be some dreadful mistake in the methodology that gives the United States the unjustified high rank of 28th place! More congenial to popular European opinion is the Climate Change Performance Index (CCPI), the product of an NGO called Germanwatch.¹ Here the United States ranks 52nd of 53 nations according to three broad measures of greenhouse gas (GHG) emissions and energy use. Even China, which now rivals the United States as the leading emitter of greenhouse gases, does better, coming in at 29th place. (An even more typical example of popular wisdom is the Happy Planet Index, where the United States is ranked 150th of 178 countries in terms of “the average years of happy life . . . per unit of planetary resources consumed,” chiefly on account of America’s carbon footprint.²)

This focus on GHG emissions points to the (endangered) elephant in the room of most environmental discourse these days, namely, the way in which nearly all environmental issues are subsumed in the dominant issue of climate change. The well-known and universally criticized reluctance of the United States to participate in the Kyoto Protocol lends sustenance to the perception that the United States is an environmental laggard if not an international scofflaw. Yet a significant recent fact has drawn insufficient notice: U.S. GHG emissions *fell* by 1.5 percent in 2006, the first time U.S. GHG emissions have fallen in a non-recessionary year. *It is likely that the United States is the only industrialized nation where GHG emissions fell in 2006.* (Emissions data for other nations for 2006 are not yet available.)

Moreover, during the last decade the United States has had the best record among industrialized nations in restraining GHG emissions. Between 1997 and 2004, the last year for which comparative data are available:

- global GHG emissions increased 18 percent;
- emissions from Kyoto Protocol participants increased 21.1 percent;
- emissions from non-Kyoto nations increased 10 percent;
- emissions from the United States increased 6.6 percent.

This array will be met immediately with a series of “*Yes, but . . .*” objections. *Yes, but . . .* the United States is so much less energy efficient than Europe or Japan. *Yes, but . . .* the United States has very high per-capita GHG emissions, showing that Americans consume too

much. *Yes, but . . .* Americans drive huge, low-mileage cars. *Yes, but . . .* think of how much better we might be if the United States showed leadership on climate change.

It is this last criticism—that the United States isn’t “leading”—that betrays the essentially Kantian preference for rhetoric over actual performance, and intention over circumstance or consequence. A serious look beyond the slogans and superficial media commentary reveals a very different picture. Sometimes even journalists notice—although, to paraphrase Churchill, they usually get up, dust themselves off, and carry on as if nothing had happened. *New York Times* columnist Tom Friedman, no shrinking violet when it comes to lacerating criticism of the United States, filed this suggestive item from the UN’s December conference in Bali on climate change:

And then something unexpected happened. For 90 minutes, Andy Karsner, who runs the Department of Energy’s renewable energy programs, James Connaughton, who heads White House climate policy, and their colleagues put on a PowerPoint performance that was riveting in its understanding of the climate problem and the technologies needed to solve it. Their mastery of the subject was so impressive that it left the room full of global activists emotionally confused . . .

This edition of the *Index of Leading Environmental Indicators* picks up the gauntlet of climate change and energy use and aims to provide a more probative picture of environmental realities today. The superior GHG performance of the United States in recent years opens onto a range of important factors that deserve closer scrutiny. Hence, this *Index* differs from previous editions in two major respects.

First, data about the range of U.S. conditions that used to compose virtually the entire report have been condensed into a few short pages. (See Web links for additional information and analysis.) For one thing, there is less reason for the exhaustive treatment formerly given here to U.S. environmental indicators now that the effort by the Environmental Protection Agency (EPA) itself to develop a regular and consistent set of environmental indicators is maturing after long years of development and delay. The EPA’s *Report on the Environment* (www.epa.gov/Envindicators/) now fills the need—to which this *Index* has long sought to draw attention—for national indicator and trend reporting, which most European nations have been doing for some time. (The EPA also has an excellent interactive Web site for its indicator set: www.epa.gov/ncea/roe.) Taking this together with the Heinz Center’s ongoing *State of the Nation’s Ecosystems* project, Americans now have excellent and accessible sources of information on environmental indicators.

This leads to the second reason for the reformatting of this *Index*, which involves the paradox of insufficient data alongside *too much* data. As the EPA, the Heinz Center, and this report have long pointed out, there are significant data gaps that prevent reaching definitive conclusions about current conditions or trends over time. In some cases, such as surface-water quality, we lack comprehensive monitoring that would enable us to judge conditions and track trends as well as we should like. In other areas there is a surfeit of data—especially data generated by remote sensing equipment and satellites—and the task of analysis and judgment is complicated by the endless ways the data can be sliced and diced into ever-finer grains.

Both the surfeit of data in some areas and the lack of data (not to mention contradictory data) in others are symptoms of the ways in which our knowledge of the environment is incomplete or contestable. As the number of possible indicators and data to support them grows, the analytical framework for making sense of the data will become more important. Data do not speak for themselves. The next generation of thinking about environmental indicators will concentrate on deciding which indicators are most meaningful, what adjustment of environmental priorities they imply, and how to match them up to policy strategies. In many cases this requires going beyond a simple indicator, such as energy or GHG emissions intensity, to compare and evaluate second-order considerations that may cast general numbers in a different light or suggest different policy routes to environmental improvement.

This 13th edition of the *Index* concentrates on energy and environmental linkages among the leading developed and developing nations, in particular the 15 nations President George W. Bush has convened to deliberate about climate change. A more fine-grained look at the data reveals a different picture from the clichés of the media and activists.

Notes:

¹ www.germanwatch.org.

² www.happyplanetindex.org.



EXECUTIVE SUMMARY

Despite the typical pessimism, signs of substantial environmental progress were reported in 2007 on both the national and global scale. Even the United Nations noted grounds for environmental optimism in two recent reports.

- The UN's *State of the Future* report notes that "People around the world are becoming healthier, wealthier, better educated, more peaceful, and increasingly connected and they are living longer," and expects this positive trend to continue.
- The UN's Food and Agricultural Organization issued its latest *State of the World's Forests* report, offering a positive outlook even in regions such as Africa that are still experiencing forest loss. Net forest loss continues to decline globally and has been reversed in Asia. The UN notes, "even in regions that are losing forest area, there are a number of positive trends on which to build."
- Net deforestation in Brazil has fallen by two-thirds over the last four years.

AIR QUALITY

In the United States several areas show continued incremental progress. In the eastern United States, recent EPA data show a 60-percent reduction in sulfur-dioxide levels since the year 2000, and a decline in emissions of nitrogen oxides (an ozone precursor) of more than 50 percent.

- In Los Angeles, air-quality regulators reported a significant decline in health risk from air pollution.
- There are positive trends overseas. India's data are choppy, but they suggest that air pollution may have peaked and even reached the cusp of declining, following the encouraging example of Mexico explored in last year's edition of the *Index*.

WATER QUALITY

The U.S. Fish and Wildlife Service released a new report on *Status and Trends of Wetlands in the United States* (the first since the year 2000), and confirmed what this *Index* has been predicting: the United States is now *gaining* wetlands.

- Rare fish species have been observed returning to the Detroit River for the first time in nearly a century.
- Russia reported significant progress in remediating the Aral Sea, site of one of the world's greatest ecological disasters. Russia is slowly restoring the lake's natural water level, and reintroducing native fish and wildlife species.
- Hypoxia in the Gulf of Mexico—the “dead zone”—reached the third-highest level ever recorded in the summer of 2007, a problem that threatens to get worse with the expansion of corn-based ethanol production.

CLIMATE CHANGE

Climate change continues to be the leading environmental issue, with new confounding findings and contradictory data appearing on an almost daily basis. While this controversy rages on, the *Index* tracks a number of policy-relevant aspects of the issue.

- U.S. greenhouse gas emissions *fell* by 1.5 percent in 2006, the first time U.S. GHG emissions have fallen in a non-recessionary year. *It is likely that the United States is the only industrialized nation where GHG emissions fell in 2006.* (Emissions data for other nations for 2006 are not yet available.)
- The reasons for the higher U.S. per-capita GHG emissions are explored in this edition. These differences include the longer transportation distances and costs in the United States and larger homes in America (roughly twice the size of the average European dwelling). When these differences are normalized, American GHG emissions are in line with most European nations.

The most important new analysis in this year's *Index* is a breakdown in practical terms of the most frequently mentioned emissions-reduction target—80 percent by the year 2050.

- The United States last emitted CO₂ at that level in the year 1910, when the population was only 92 million. By 2050, the United States will have 420 million people, requiring a per-capita emissions rate not seen in the nation since 1875.
- To achieve the 80-percent reduction target in 2050, U.S. per-capita emissions will have to be less than 2.5 tons (down from approximately 20 tons today). The only nations today that have GHG emissions that low are desperately poor nations, such as Haiti and Somalia.¹ Even France and Switzerland, the two industrialized nations with the lowest use of fossil-fuel energy sources, emit about 6.5 tons of CO₂ per capita.
- Automobile fuel consumption will have to fall by more than 80 percent.
- Unless there is a genuine breakthrough in carbon-free electricity, households will not be able to use enough electricity to run a hot-water heater without exceeding the 2.5 tons per-capita emissions ceiling.
- The 80 percent reduction target is unrealistic at any price, akin to King Canute commanding the tides, or the equivalent of John F. Kennedy pledging the nation in 1961 to land a man on Mars by the year 1970.

Notes:

¹ See http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/001345carbon_emissions_suc.html.

"On what principle is it that, when we see nothing but improvement behind us, we are to expect nothing but deterioration before us?"

—Thomas Babington Macaulay, 1830

Introduction

THE YEAR IN REVIEW

Commentator and occasional presidential candidate Pat Buchanan has a new book out, *Day of Reckoning: How Hubris, Ideology, and Greed Are Tearing America Apart*. This follows hard on such recent Buchanan works as *State of Emergency* and *The Death of the West*.

What do these gloomy Buchanan titles have to do with the environment?

Well, nothing, really. But they do serve to illustrate a broader point about the split character of the American mind. Americans, generally the happiest and most optimistic people on the planet, have always been filled with apocalyptic forebodings, fascinated by preachers of doom, and given to puritan crusades to redeem the land and nation. The persistence of doomsaying is not limited to the environment, as the Buchanan example attests.

While a trip down the environment/earth-sciences aisle of the local bookstore is usually a tour of titles that cover the range from dismay to despair, titles predicting decline, decay, and disaster are just as numerous on the real-estate, economics, and social-science shelves (though, ironically, not so much on the religion racks). The main difference between eco doom and economic doom is that the inventive American mind can always find the upside to the downside when there might be a business opportunity; hence the popularity of titles such as *How You Can Profit from the Coming Crash in . . . [Fill in the Blank]*.

Indeed, one of the most popular books of 2007 among environmentalists was *The World without Us* by Alan Weisman, a “thought experiment” about what would occur if human beings were suddenly somehow



removed entirely from the planet. Answer: Nature would reassert itself and remove nearly all traces of human civilization within several millennia. Naturally, many environmentalists thrilled to the *frisson* of the book's nightmare scenario of the


ruin of mankind's built environment, which Weisman shrewdly gilded with the standard boilerplate about resource exhaustion and overpopulation. The book rocketed up the best-seller list, the latest in a familiar genre.¹

THE ONLY THING WE HAVE TO FEAR IS FEAR ITSELF

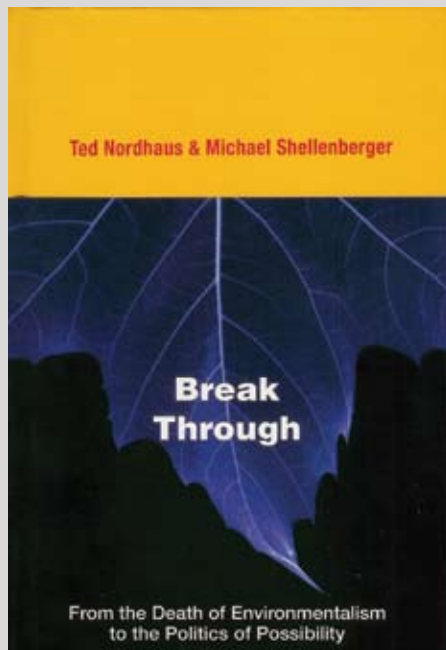
"You'd think that the American public would get tired of the unrelenting gloominess of the far right and left," *Los Angeles Times* columnist Gregory Rodriguez wrote in a perceptive article about this paradox late last year. "But you'd be wrong. It's part of who we are, the flip-side of our patriotic jingoism and a legacy of those intensely religious Puritans that lives on in this secular age."² The same America that likes to obsess over prospective disaster also responds favorably to the optimism of Franklin Roosevelt ("The only thing we have to fear is fear itself") or Ronald Reagan (America is "a shining city on a hill"—though, in confirmation of Rodriguez's thesis, Reagan privately thought often about Armageddon).

It is precisely this enduring American strain of redemption and recovery that has been conspicuously absent from popular environmental thought in modern times. And this constitutes the chief limiting factor for environmentalism. Two of the most typical reactions to the data about environmental progress in America given in previous editions of this *Index* have been anger and rage—based not on errors in the data, but on the emotive ground that it is perverse to deny that the earth is doomed.

This *Index* has continuously looked for and tracked signs that this debilitating state of affairs might be changing for the better. Opinion polls have shown some important shifts. While overwhelming majorities of Americans tell pollsters that the environment is a very serious issue (but then Americans like to worry about everything, such polls show) and that overall environmental quality is deteriorating, an increasing proportion of Americans tells pollsters that environmental quality in *their local area* has improved or is satisfactory.



It is precisely this enduring American strain of redemption and recovery that has been conspicuously absent from popular environmental thought in modern times.



Here and there are other signs that we may have arrived at a moment of “punctuated equilibrium”—the term Stephen Jay Gould popularized to describe sudden and dramatic bursts of activity in evolution preceded and followed by long periods of stability or stagnation. Two important books in 2007 point to significant changes in our environmental outlook.

First, Ted Nordhaus and Michael Shellenberger published their long-awaited book following up on their notorious 2005 memo on “The Death of Environmentalism.” In *Break Through: From the Death of Environmentalism to the Politics of Possibility*,³ Nordhaus and Shellenberger scorn the apocalypticism that has dominated environmental discourse, seeing its essential

pessimism as a hindrance to political and social success. They also acknowledge and repudiate the misanthropy that often comes to the surface in environmental agitation; humans and what we make are a part of the planet's environment, too. Environmentalists "see in housing development only the loss of nonhuman habitat—not the construction of vital human habitat. Thus, the vast majority of environmental strategies aim to *constrain* rather than *unleash* human activity."

Nordhaus and Shellenberger also reject environmental romanticism, noting, as with other forms of political romanticism, its danger: "Environmental tales of tragedy begin with Nature in harmony and almost always end in quasi-authoritarian politics." While the authors' recommendation that the environmental movement reconstitute itself within a broad-spectrum "progressive" movement may be doubtful, their serious self-criticism from within the environmental movement is a refreshing and positive development.

The second notable book of 2007 is Seymour Garte's *Where We Stand: A Surprising Look at the Real State of Our Planet*.⁴ Garte, professor of environmental and occupational health at the University of Pittsburgh's Graduate School of Public Health, relates the story of attending a professional conference in Europe. He was surprised by the data presented by a speaker showing steadily declining air-pollution trends, and he was even more surprised to hear the speaker say, "Everyone knows that air pollution levels are constantly decreasing everywhere."

"I looked around the room," Professor Garte writes.

I was not the only nonexpert there. Most of my other colleagues were also not atmospheric or air pollution specialists. Later I asked one of them, a close friend, if he had known that air pollution levels were constantly decreasing throughout Europe and the United States on a yearly basis. "I had no idea," he said. It certainly was news to me. Even though I was a professor of environmental health and had been actively involved in many aspects of air pollution research for many years, that simple fact had somehow escaped me. . . . I had certainly never seen it published in the media.

Garte goes on to argue that excessive pessimism about the environment undermines good scientific investigation and distorts our understanding of important environmental challenges. He criticizes anti-technological biases prevalent among environmentalists, but is also skeptical that market forces alone will suffice to continue our environmental progress in the future. He is guardedly optimistic that the creativity and adaptability of the human species will enable us to confront surprises and new problems.



"We should pay attention to our successes as well as our failures," Garte writes, "because in order to know where to go next, it is just as important to know where (and how) we went right as it is to know where we have gone wrong."

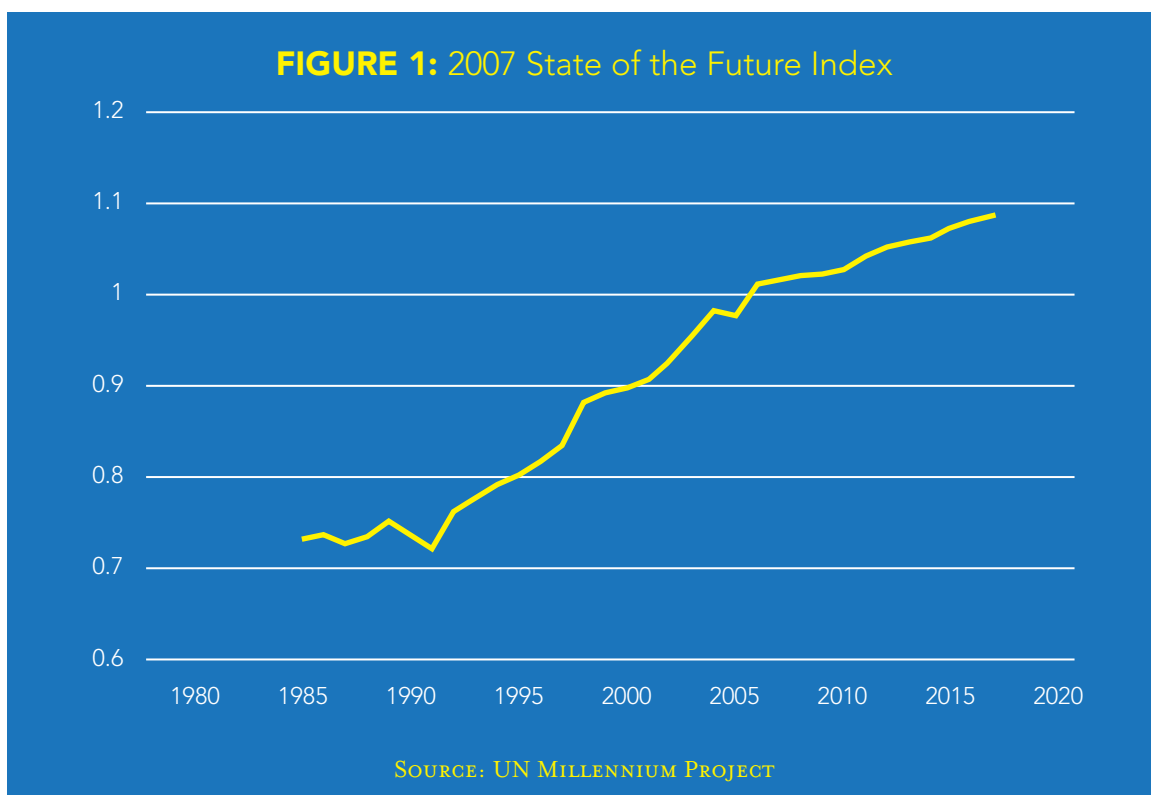
But the most comprehensive case for global optimism comes from a most surprising source—the United Nations. The UN is usually a reliable source of global pessimism, but its latest *State of the Future* report, while duly noting the typical sources of worry, comes down on the side of optimism about global progress and continued improvement in the future.

"People around the world are becoming healthier, wealthier, better educated, more peaceful, and increasingly connected and they are living longer," the report begins. The report expects that world poverty will be cut in half over the next decade; it rejoices that the number of nations rated as "free" by Freedom House has nearly doubled over the past 30 years, from 46 to 90. Global population growth is moderating, and the

report cautiously embraces the forecast that by 2100, global population may *fall* by one billion people from its current level.

The *State of the Future* report is part of the UN's Millennium Project, and it boils down the project's work into a State of the Future Index (SOFI), with a range of predicted progress 10 years out. Constructed with a set of 29 variables (only a few of which are environmental), the SOFI is projected to rise from a value of 1.0 in 2006 to about 1.08 in 2017, with some scenarios taking the SOFI as high as 1.16 by 2017. This would represent a move from about 0.72 in 1992 (see Figure 1).⁵

Indices such as the SOFI are obviously dependent on the choice and weighting of variables, along with projections of various plausible scenarios for changes in these variables in the near and intermediate future. As such they are vulnerable to endless methodological criticism and correction. What is notable, however, is that, notwithstanding all the reasons for concern, even the UN can't avoid the conclusion of steady progress.



Notwithstanding all of the reasons for concern, even the United Nations can't avoid the conclusion of steady environmental progress.



VANISHING BEES AND UNLEADED SQUIRRELS

Last year also offered some evidence that what might be called the Environmental Alarm Cycle (that is, the sudden appearance, investigation, and resolution of a potential environmental crisis) has shortened. Springtime brought a flurry of news headlines that the honeybee population was undergoing a dramatic and precipitous crash. BEES VANISH, AND SCIENTISTS RACE FOR REASONS, the *New York Times* reported on April 24.⁶ “More than a quarter of the country’s 2.4 million bee colonies have been lost—tens of billions of bees, according to an estimate from the Apiary Inspectors of America,” the *Times* reported. By the summer of 2007 it was estimated that 50 to 90 percent of American bee colonies were being devastated. Overnight the phenomenon was given a proper name: Colony Collapse Disorder (CCD), and the U.S. Department of Agriculture declared the matter to be “a crisis.”

As usual, the default position was that CCD must have man-made environmental causes. As the *Times* put it: “As with any great mystery, a number of theories have been posed. . . . People have blamed genetically modified crops, cellular phone towers and high-voltage transmission lines for

the disappearances.” Another all-purpose villain—pesticides—was also prominently included in the causal speculation. The Sierra Club didn’t wait for investigators to weigh in; it launched a letter-writing campaign to Congress, arguing that “[h]ighly respected scientists believe that exposure to genetically engineered crops and their plant-produced pesticides merit serious consideration as either the cause or a contributory factor to the development and spread of CCD.” None of the underlying studies the Sierra Club cited supported this assertion, science writer Ronald Bailey pointed out.⁷

Since bees are essential agents in pollination, their decline was made into a harbinger of a wider crisis in the food chain (notwithstanding the estimated 17,000 other species of bees, none of which seemed to be affected by CCD, and another 200,000 species of insect and animal pollinators). Perhaps, to mix species, beehives are the canary in the coalmine, somehow a sign of the unsustainability of human civilization itself. The *Washington Post*’s Joel Garreau captured the fast-spreading popular mood: “If what you’re searching for is an entire spectrum



The EAC (Environmental Alarm Cycle)—that is, the sudden appearance, investigation, and resolution of a potential environmental crisis—appears to have shortened in 2007.

of moral lessons regarding the evils of human behavior, this crisis is even better than global warming.”⁸

But the crisis didn’t last very long.

By July, *New York Times* science writer Andrew Revkin was throwing cold water on the alarmism in a story with the predictable revisionist headline, BEES DYING? IS IT A CRISIS OR A PHASE? As Revkin noted, “Now, however, some experts on insect biology and bee rearing are questioning how unusual the die-offs are, saying commercial beekeeping has long had a pattern of die-offs, and without better monitoring, there is not enough information to know if anything new or calamitous is happening.”⁹ In September the crisis was largely called off when *Science* magazine published a study that identified a new viral infection as the agent behind the bee die-off.¹⁰ The study, led by a team of 22 scientists affiliated with

Penn State, conducted an extensive DNA analysis of bees from CCD colonies, and found what has been called Israeli Acute Paralysis Virus (IAPV) “strongly correlated with CCD.” Although CCD is by no means over, once human agency had been ruled out as a primary cause, public and media interest waned quickly.

“It is not cell phones, the Rapture, ocean seeding, jet contrails, cannibal bees, a Russian plot, avian flu, spirit ecology, crop circles, or a number of other similar possible causes suggested to us,” said University of Montana bee researcher Jerry Bromenshenk in December.

An equally short-lived alarm concerned leaved squirrels in New Jersey. In January of last year the New Jersey State Department of Health and Senior Services issued an advisory urging hunters to limit their consumption of squirrel meat based on

high lead levels found in tissue from squirrels captured near a toxic waste dump. But the advisory was cancelled a few months later when retesting found the original result (conducted by the federal EPA) was erroneous, and that squirrel lead levels were normal and safe.

In one of those “more-information-that-you-need-to-know” episodes, it turned out that the source of the lead was the

EPA’s blender used to process squirrel tissue samples. Local environmentalists—not to mention hunters—were not amused, or reassured. The director of the Edison Wetlands Association, Robert Spiegel, told the Associated Press: “Even if you do believe that they had some sort of blender malfunction, it’s still not good news. It actually raises a lot of red flags about all the other work that the EPA has done up there. How do we trust the rest of what the EPA is telling us?”¹¹

Notes:

¹ One of the few reviewers with a negative appraisal was the *Washington Post*’s Michael Grunwald, who wrote (July 29, 2007): “Imagining the human footprint on a post-human planet might be fun for dormitory potheads who have already settled the questions of God’s existence and Fergie’s hotness, but it’s not clear why the rest of us need this level of documentary evidence.”

² Gregory Rodriguez, “We’re on the Brink of Apocalypse! Again!” *Los Angeles Times*, December 3, 2007, <http://www.latimes.com/news/opinion/la-oe-rodriguez3dec03,0,4262325.column?coll=la-opinion-righttrail>.

³ Houghton Mifflin, \$25.00.

⁴ Amacom, \$24.95.

⁵ See www.millennium-project.org/millennium/SOFI.html.

⁶ By Alexei Barrionuevo, April 24, 2007.

⁷ “Plight of the Bumblebee,” Reason online, April 13, 2007, <http://www.reason.com/news/show/119622.html>

⁸ Joel Garreau, “Honey, I’m Gone: Abandoned Beehives Are a Scientific Mystery and a Metaphor for Our Tenuous Times,” *Washington Post*, June 1, 2007.

⁹ July 17, 2007.

¹⁰ Diana L. Cox-Foster, et al., “A Metagenomic Survey of Microbes in Honey Bee Colony Collapse Disorder,” *Science*, September 6, 2007.

¹¹ Associated Press, “EPA: Defective Test Led to Squirrel Lead Warning,” October 29, 2007.

AIR QUALITY

The EPA has revised and updated its emissions inventory and ambient air quality levels for the six criteria pollutants through calendar year 2006, though many of the raw data are not easily accessible on the EPA's Web site.¹ Table 1 displays the EPA's calculation of the improvement in average ambient air quality and emissions for the nation as a whole from 1980 through 2006.

Table 1: Change in National Average Ambient Levels and Emissions
1980–2006*

	AMBIENT	EMISSIONS
Carbon Monoxide (CO)	–75%	–50%
Ozone** (O ₃)	–21%	–52%
Lead	–96%	–97%
Nitrogen Dioxide (NO ₂)	–41%	–33%
Particulates (PM ₁₀), 1990–2006	–30%	–28%
Fine Particulates (PM _{2.5}), 2000–2006	–14%	–31%
Sulfur Dioxide (SO ₂)	–66%	–47%

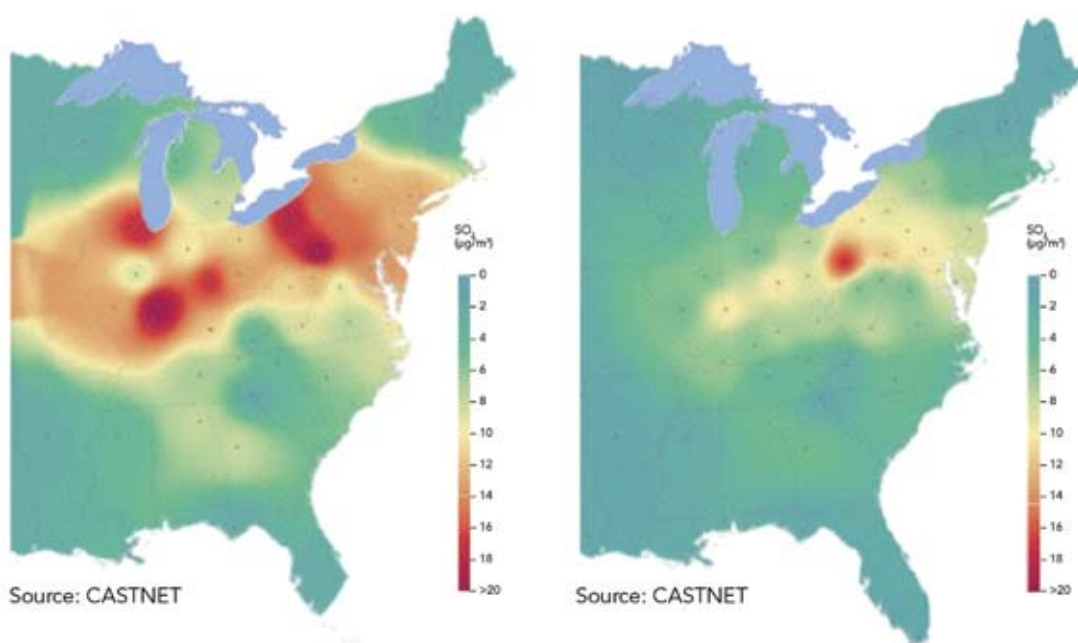
* Except for PM₁₀ and PM_{2.5}

** Emissions measure here is volatile organic compounds (VOCs), a principal ozone precursor.

SOURCE: EPA



Figure 1: Ambient Mean SO₂ Concentration, 1989–1991, 2003–2005



SOURCE: EPA, *Acid Rain Program 2005 Progress Report*

Average national statistics understate the magnitude of improvement; areas of the nation with the highest pollution levels have improved the most.





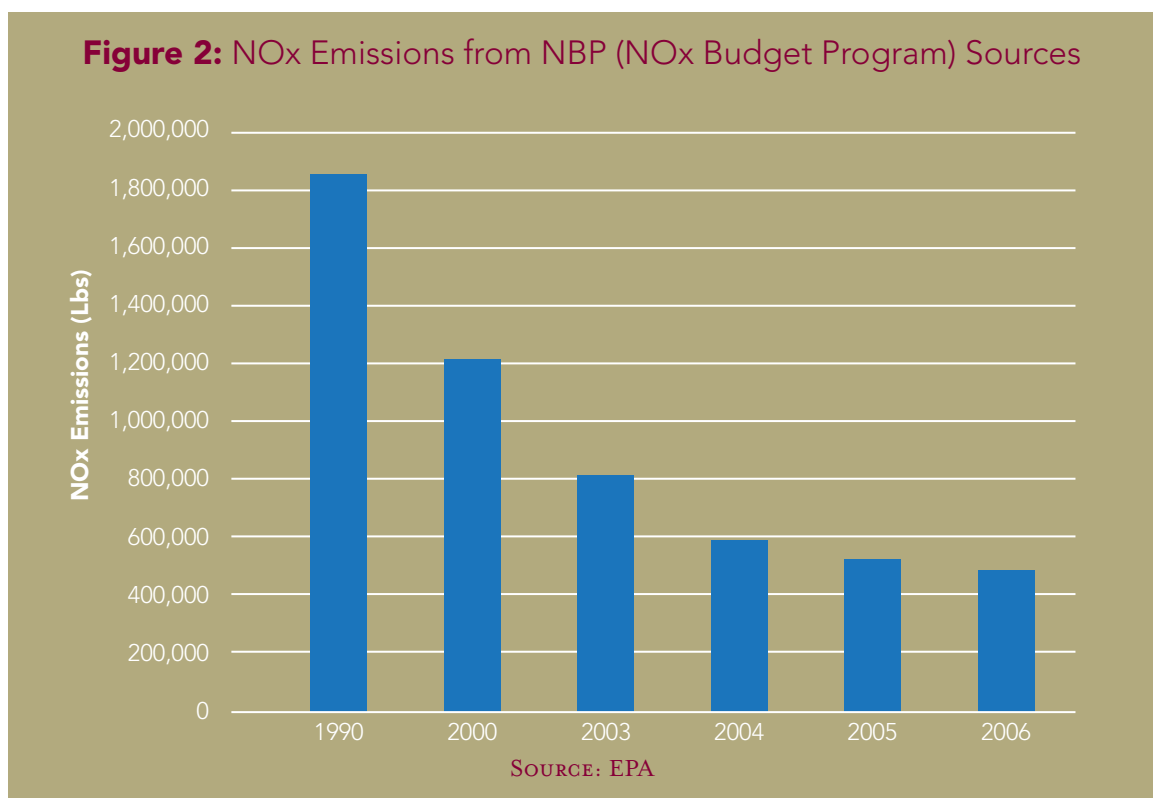
One of the reasons the EPA has discontinued the regular annual publication of its *National Air Quality Status and Trends* report is that the continuing incremental progress, while significant, does not show up as clearly in aggregate national statistics. (Also, the availability, convenience, and timeliness of the Internet make a bound, printed annual report less necessary. Good for the EPA; it's saving some trees.) More important is that the average national statistics understate the magnitude of improvement.

As has been pointed out before, *areas of the nation with the highest pollution levels have improved the most*. Los Angeles, for example, has gone from nearly 200 high-ozone days a year in the 1970s to fewer than 25 days a year today. Many areas of the Los Angeles basin are now smog-free year round. (For a detailed analysis of the complete trends, see the new book from Joel Schwartz and Index author Steven Hayward, *Air Pollution in America: A Dose of Reality on Air Pollution Levels, Trends, and Health Risks*.²)

Meanwhile, the EPA has turned its efforts to detailed reports on specific aspects of air-quality problems that are useful in dramatizing the results. One of the most important is the *Acid Rain Program 2005 Progress Report*, released in late 2006, which covers a large subset of the regulatory effort to reduce sulfur dioxide. While aggregate statistics convey the overall trend, two color-shaded maps in the report dramatize what these improvements mean "on the ground." Figure 1 displays ambient sulfur-dioxide levels in the eastern United States from 1989 to 1991 and from 2003 to 2005.

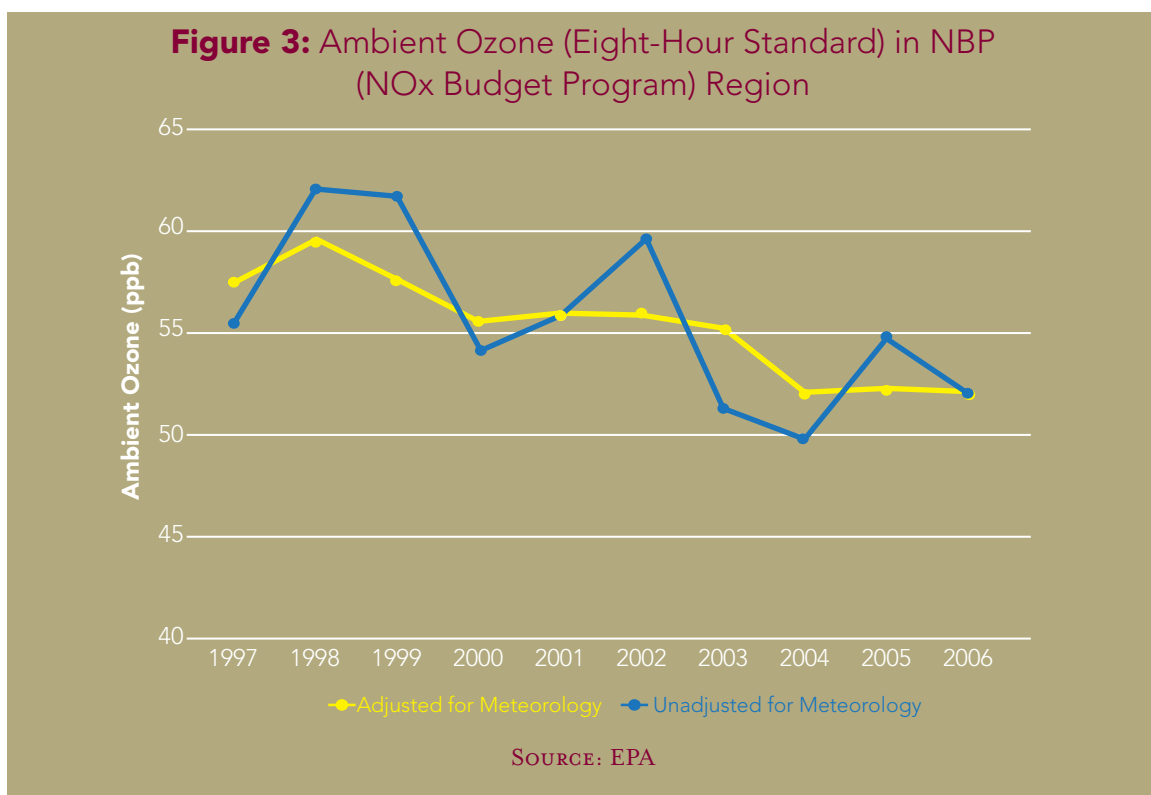
The other notable EPA effort is the *NOx Budget Trading Program 2006 Program Compliance and Environmental Results Report*.³ This report covers the EPA's effort to reduce NOx emissions, chiefly from electric-utility power plants, in the summer months in 21 eastern states. The effort is aimed at lowering summertime ozone levels along the Atlantic seaboard and in the Ohio





Valley. Figure 2 displays the reduction in emissions from sources included in the program—60 percent since 2000, when the program began, and 73 percent since 1990. The EPA believes that these NOx reductions have contributed to lowering average ozone levels in the targeted eastern region by about 5 percent over the last five years

(emissions reductions from the auto fleet and other sources have also contributed to this result). Figure 3 displays the ambient ozone trend (measured according to the eight-hour standard) in the eastern states covered in the program, with an interesting wrinkle: the EPA has adjusted ozone levels for temperature and meteorological conditions.



These findings suggest that the environmental concerns of antiglobalization protesters have been overblown, and that the pollution reduction achieved by U.S. manufacturing will be replicable by other countries in the future.



INDIA: TURNING THE CORNER ON AIR POLLUTION?

The 11th edition of this *Index* (2006) reported on declining air pollution trends observed in Mexico City and some Chinese cities, despite (or actually because of) rapid economic growth. India offers some evidence that its severe air pollution problems may be turning the corner.

Data from the Central Pollution Control Board show declining trends of sulfur dioxide, nitrogen dioxide, and particulates. (India uses a PM_{10} standard to denote SPM [suspended particulate matter]—particles of ten microns or less.)⁴ India does not currently monitor or report ozone levels. Figures 4–6 display ambient annual average levels for SO_2 , NO_2 , and particulates in Delhi industrial areas, which have the highest pollution levels in the region. Delhi displays a declining trend in SO_2 and particulates, but a rising trend in NO_2 , which is also the most stubborn air pollutant in the United States.

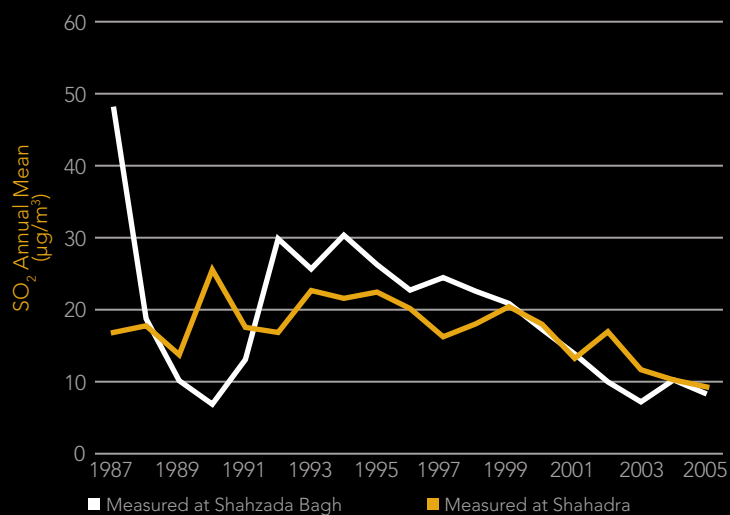
There are a number of gaps and inconsistencies in India's monitoring data, and some of the variation and volatility in the trends are related to high variations in meteorological conditions. Nevertheless, some of these findings are exactly what would be predicted by the "Environmental Kuznets Curve," i.e., that economic growth is the cornerstone of transition from environmental degradation to improvement.



Figure 4:

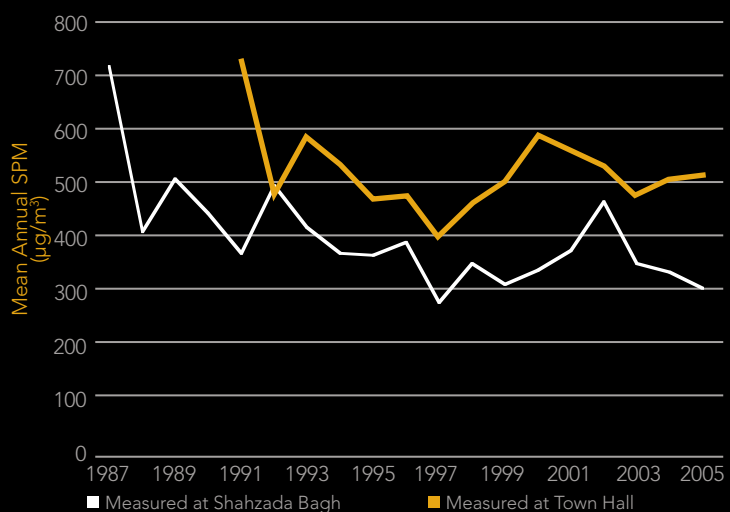
Ambient Annual Average SO_2 Levels in Delhi Industrial Areas

SOURCE: Ministry of Environment and Forests, Government of India

**Figure 5:**

Ambient Annual Average Particulates in Delhi Industrial Areas

SOURCE: Ministry of Environment and Forests, Government of India

**Figure 6:**

Ambient Annual Average NO_2 in Delhi Industrial Areas

SOURCE: Ministry of Environment and Forests, Government of India



OTHER AIR-QUALITY NEWS

- A recent study from the National Bureau of Economic Research (NBER) offers new evidence of the genuine improvement in air quality in America's manufacturing sector, and debunks a familiar cliché about globalization.⁵ Over the last 30 years, air pollution emissions from the manufacturing sector in America have fallen by about 60 percent, while real manufacturing output increased by 70 percent. Sometimes this trend is discounted with the argument that the United States has merely "outsourced" pollution by moving high-pollution activities overseas or buying more high-pollution products (autos, for example) from overseas. If this argument were correct, it would mean that there is little or no reduction in air pollution taking place globally.

Georgetown University economist Arik Levinson looked into this matter with a detailed analysis of technological changes and manufacturing trade flows over the last 30 years, and reached the conclusion that "most of the environmental improvements in the United States have come from technology, not from relocating polluting industries overseas." The study offers encouragement for those emerging economies (India, China, Indonesia, and so forth) currently struggling with high levels of air pollution as their economic growth gallops forward. Levinson suggests that U.S. trends have global significance: "These findings suggest that the environmental concerns of antiglobalization protesters have been overblown, and that *the pollution reduction achieved by U.S. manufacturing will be replicable by other countries in the future*" (emphasis added).

- The South Coast Air Quality Management District (SCAQMD) in southern California released a study in January concluding that cancer risk from air toxics had fallen 17 percent over the last seven years, with the most significant gains coming in the places with the highest levels of air pollution emissions—rail yards, ports, and areas near freeways.⁶ The cancer risk from current air pollution levels is arguably modest to begin with—the latest study estimates the cancer risk at around 1,000 to 1,200 cases per million people over 70 years, or less than 0.48 percent of all likely cancer cases in that time frame. At that, this estimate is vulnerable to the criticism that changes in it are impossible to disentangle from background "noise" in the data and other confounding effects (e.g., diet is obviously a factor of many orders of magnitude higher than air pollution).

Notes:

¹ <http://www.epa.gov/airtrends/>.

² Joel M. Schwartz and Steven F. Hayward, *Air Pollution in America: A Dose of Reality on Air Pollution Levels, Trends, and Health Risk* (Washington, D.C.: AEI Press, 2008).

³ Environmental Protection Agency, *NOx Budget Trading Program 2006 Program Compliance and Environmental Results* (Washington, D.C.: Environmental Protection Agency, 2007).

⁴ www.cpcb.nic.in/Air/Air.html.

⁵ Arik Levinson, "Technology, International Trade, and Pollution from U.S. Manufacturing," NBER Working Paper 13616, November 2007, available online at: www.nber.org/papers/w13616.

⁶ Janet Wilson, "Cancer Risk from Toxic Air Declines," *Los Angeles Times*, January 5, 2008, p. A1.



WATER QUALITY

THE YEAR IN WATER

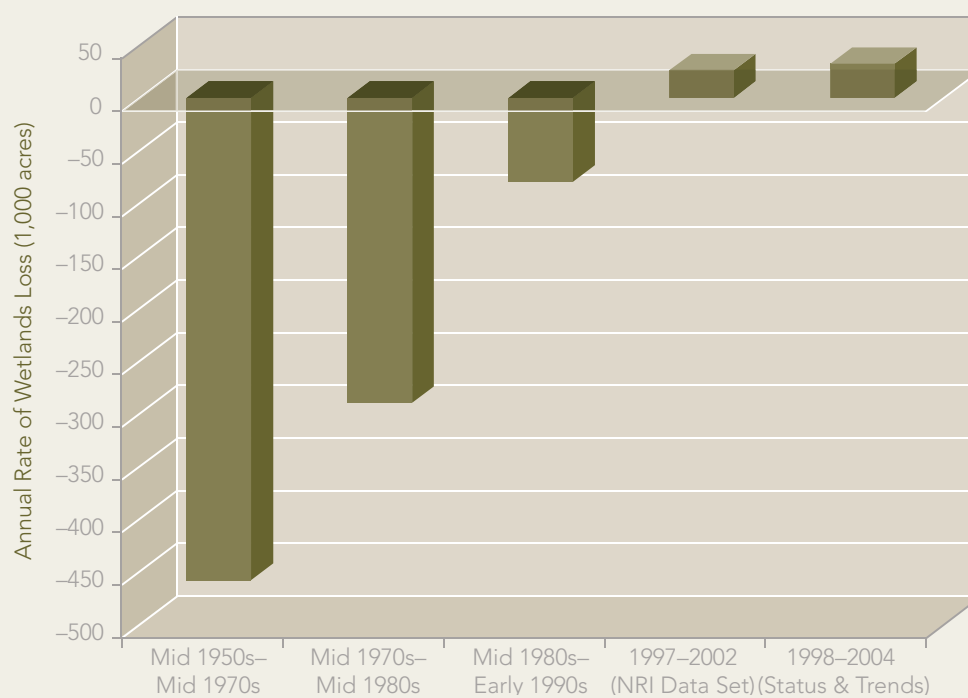
Consistent time-series water-quality monitoring, as this and other reports on environmental indicators have long lamented, is still not adequately performed in the United States, although there is some promise of better data in the years ahead from the National Wadeable Streams Assessment, highlighted in last year's edition of the *Index*. While we await the development of better indicator data sets, there are many news items and partial data sets about particular regions and specific water-quality issues that provide useful information about trends.

The most significant water-quality news of last year concerns wetlands. As far back as the sixth edition of this report (2001) we speculated that the United States might have reversed wetlands loss and might now

be gaining net wetland area. The last periodic Fish and Wildlife Service report on *Status and Trends of Wetlands in the United States*, issued in 2000, showed that annual wetlands loss had fallen from nearly 500,000 acres per year in the 1950s to less than 80,000 acres per year by the early 1990s. By 2005, a separate data set from the Department of Agriculture's National Resources Inventory for 1997–2002 supported our conjecture, showing a net gain in wetlands of 26,000 acres per year.

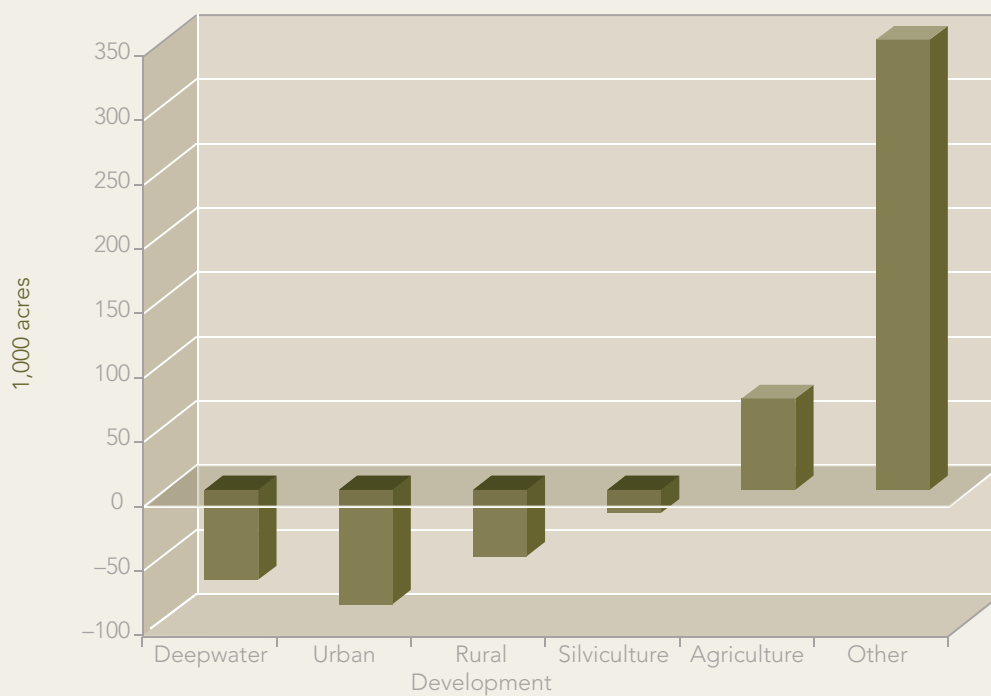
In late 2006 the Fish and Wildlife Service released a new *Status and Trends* report covering the time period of 1998–2004, which confirms that the United States has been gaining wetlands at a rate of about 32,000 acres per year over the last decade (see Figure 1).

Figure 1: Wetlands Loss, 1950s–2004



SOURCE: FISH AND WILDLIFE SERVICE, *Status and Trends*; NATIONAL RESOURCES INVENTORY

Figure 2: Wetlands Change by Land-Use Category, 1998–2004



SOURCE: FISH AND WILDLIFE SERVICE, *Status and Trends*

Wetlands are not uniform, and neither are the trends within the larger subcategories of wetland types. The largest gains have been achieved in agricultural lands and deepwater habitats, which include lakes and

ivers and other permanent water bodies with different characteristics from swamps and other fluctuating wetlands. Urban and rural wetlands still show declining trends (see Figure 2).

OTHER WATER NEWS

- The U.S. Geological Survey (USGS) reported in late 2006 the discovery of the first reproducing population of whitefish in the Detroit River since 1916. “The return of lake whitefish to the Detroit River is partly the result of 40 years of pollution prevention and control activities in the Detroit/Windsor metropolitan areas,” said Leon Carl, Center Director, USGS Great Lakes Science Center.¹
- Hypoxia (low oxygen level) in the Gulf of Mexico—the adverse trend of the so-called “dead zone” noted in previous editions of this report—reached its third-highest level ever recorded in the summer of 2007, though at 7,900 square miles it was slightly lower than had been predicted. Some hypoxia is naturally occurring, but most of the growth in Gulf hypoxia is attributed to agricultural runoff. The policy goal for the Gulf is to reduce the annual peak hypoxia level to 2,500 square miles. However, the boost in corn-based ethanol production (the amount of corn currently being planted in the United States is the highest since 1944) is likely to increase nutrient runoff in the Mississippi River and make the problem of Gulf hypoxia worse.
- From Kazakhstan comes welcome news of progress in the restoration of one of the world’s pre-eminent scenes of ecological disaster from the last century: the Aral Sea. “Sea” is a misnomer; the Aral is a freshwater body straddling Kazakhstan and Uzbekistan, and was once the fourth-largest freshwater body in the world. The Soviet Union diverted 75 percent of the Aral Sea’s water during the second half of the twentieth century for massive irrigation projects, and the resulting drop in the Aral’s level led to the desertification of the region, killing most of the fish in the Aral and destroying much of the local economy. Now the process has been reversed, and over the last few years the Aral Sea’s volume has grown back by 30 percent, to a level of 38 meters from a low of 30 meters. It is two-thirds of the way back to the level of 42 meters considered necessary for its natural ecosystem to be viable once again. Fish are slowly returning, and there are plans to begin restocking the Aral with additional native fish species.

Notes:

1 <http://soundwaves.usgs.gov/2006/08/research.html>.



LAND AND FORESTS

STATE OF THE WORLD'S FORESTS 2007

The seventh biennial *State of the World's Forests*¹ report was issued by the UN's Food and Agriculture Organization (FAO) in 2007. The report offers confirmation of the positive findings of a separate UN forest-tracking effort, the Global Forest Resource Assessment (GFRA), summarized in last year's edition of the *Index* (p.36). The *State of the World's Forests* report utilizes GFRA data, but supplements them with data from other national and international sources to attempt to provide a more detailed picture, especially of policy efforts to affect forest trends and conditions.² As with the GFRA, *State of the World's Forests* notes that "[t]he biggest limitation for evaluating progress is weak data.

Relatively few countries have had recent or comprehensive forest inventories."

State of the World's Forests represents another striking departure from the typical pessimism of past global assessments. It concludes that progress is being made, albeit unevenly and with net forest losses still occurring in some regions, especially Africa and Latin America. Yet the report strikes repeated optimistic notes: "[E]ven in regions that are losing forest area, there are a number of positive trends on which to build." *State of the World's Forests* divides the world into six major regions, and even in the areas experiencing forest loss it still finds positive developments and grounds for optimism for the future:

- **AFRICA:** “During the 15-year period from 1990 to 2005, Africa lost more than 9 percent of its forest area But the picture is not all gloomy. Forests are obtaining political support and commitment at the highest levels in Africa.”

BEST-PERFORMING AFRICAN NATION: Rwanda (6.9 percent annual forest-area increase from 2000 to 2005).

WORST-PERFORMING AFRICAN NATION: Burundi (–5.2 percent).

- **ASIA AND THE PACIFIC:** “The good news for the Asia and Pacific region is that net forest area increased between 2000 and 2005, reversing the downward trend of the preceding decades [T]here are a number of positive trends that support an optimistic view of the future. Rapid economic growth in the two largest countries, China and India, may help to create the conditions for sustainable forest management.”

BEST-PERFORMING ASIA/PACIFIC NATION: China (2.2 percent).

WORST-PERFORMING ASIA/PACIFIC NATIONS: Pakistan and the Philippines (–2.1 percent).

- **EUROPE:** “Forest area is increasing in most countries, and the positive trends exceed the negative.”

BEST-PERFORMING EUROPEAN NATION: Spain (1.7 percent).

(Several European nations tied at zero; none have negative forestation rates, with the possible exception of the Russian Federation, where the data are incomplete.)

PRIVATE LAND TRUSTS ON THE RISE

In late 2006, the Land Trust Alliance (www.lta.org) released a census of private land trusts in the United States, showing the dramatic and substantial rise in private conservation activity in recent years:

- Over the period of 2000–2005, total acres conserved by private land trusts increased 54 percent, to 37 million acres, or an area more than 16 times the size of Yellowstone National Park. There were, as of the end of 2005, 1,667 private land trusts in the United States, a 32-percent increase from the year 2000. Further, more than \$1 billion has been set aside in private endowments for the support and management of land trusts.

- **LATIN AMERICA AND THE CARIBBEAN:** "Latin America and the Caribbean join Africa as the two regions that are losing forests at the highest rates. The annual net rate of loss between 2000 and 2005 (0.51 percent) was higher than that of the 1990s (0.46 percent)."

BEST-PERFORMING LATIN AMERICAN NATION: Cuba (2.2 percent).

WORST-PERFORMING LATIN AMERICAN NATION: Honduras (−3.1 percent).

- **NEAR EAST:** "Largely because of the arid climate, the forest sector in the Near East region represents a small part of the economy . . . Despite the problems and limitations faced by countries in the region, progress is being made to develop strategies and implement programmes that effectively address local conditions."
- **NORTH AMERICA:** "Net forest area is stable in Canada and the United States. It is declining in Mexico, but the rate of decrease is slowing and is much less than the rate of forest loss in Central America."

BEST-PERFORMING NORTH AMERICAN NATION: United States (0.1 percent).

WORST-PERFORMING NORTH AMERICAN NATION: Mexico (−0.4 percent).

One obvious fact jumps out from this compilation: forest stress is highest in poor nations. The finding of the National Academy of Sciences' review of these data from last year bears repeating: "No nation where annual per-capita gross domestic product exceeded \$4,600 had a negative rate of growing stock change."

- 
- If private land-conservation efforts continue at the current pace, by the year 2010 the amount of land under private conservation management will reach 43 million acres—an area larger than the state of Florida.
 - Private conservation efforts are growing increasingly sophisticated, with a burgeoning of online tools and resources to assist landowners as they explore the range of conservation options. One of the best is <http://privatelandownernetwork.org/>, a project of Resources First Foundation (motto: "Private Sector Solutions for the Environment"), <http://resourcesfirstfoundation.org/>.

Table I displays the estimates of absolute area and rate of change for the six regions plus the Russian Federation (usually reported together with Europe, but its massive size skews the summary numbers).

Table 1

REGION	AREA (1,000 HECTARES)			ANNUAL CHANGE (1,000 HECTARES)		ANNUAL CHANGE RATE (%)	
	1990	2000	2005	1990–2000	2000–2005	1990–2000	2000–2005
Africa	669,361	654,613	635,412	–4,375	–4,040	–0.64	–0.62
Asia & Pacific	743,825	731,077	734,243	–1,275	633	–0.17	0.09
Europe	180,370	188,823	192,604	845	756	0.46	0.40
Russian Fed.	808,950	809,268	808,790	32	–96	0.00	–0.01
Latin America	923,807	882,339	859,925	–4,147	–4,483	–0.46	–0.51
Near East	127,966	123,045	120,393	–492	–530	–0.39	–0.43
North America	677,798	677,968	677,461	17	–101	0.00	–0.01
World	4,077,291	3,988,610	3,952,025	–8,868	–7,713	–0.22	–0.18

NEW UNCERTAINTIES ABOUT CONDITIONS AND TRENDS

Last year's edition of the *Index* referred to the findings of the most recent GFRA (for the year 2005), which reported a significant drop in the rate of global deforestation, from about 8.9 million hectares a year in 1990–2000 to about 7.3 million hectares per year in 2000–2005. A reanalysis of the GFRA's data published by the National Academy of Sciences further noted that some important transitions had taken place, such that key areas of Asia had halted deforestation and were experiencing net reforestation.³ However, a number of anomalies and inconsistencies in the data series were evident, casting doubt on the accuracy of the estimates. (For example, the GFRA's data for forest trends in the United States and Europe don't match up with U.S. data or European Environment Agency data.)

A fresh study published early this year by the National Academy of Sciences reviewed the data inconsistencies for tropical forests and cast doubt on whether estimates of net tropical deforestation are accurate, noting that each successive revision to previous data reported a declining deforestation rate, based on new data and changes in statistical design.⁴ British geographer Alan Grainger concludes that “the evidence for [tropical forest] decline is not as clear as commonly assumed, even since the 1970s, by when as much as 300 million

UN: "FOREST AREA IS INCREASING IN MOST COUNTRIES, AND THE POSITIVE TRENDS EXCEED THE NEGATIVE."

hectares of tropical forest may have already been cleared since 1860 alone." Grainger identified one time series that actually finds a long-term trend of increase, not decrease, for tropical forest area, a phenomenon Grainger calls "forest return."

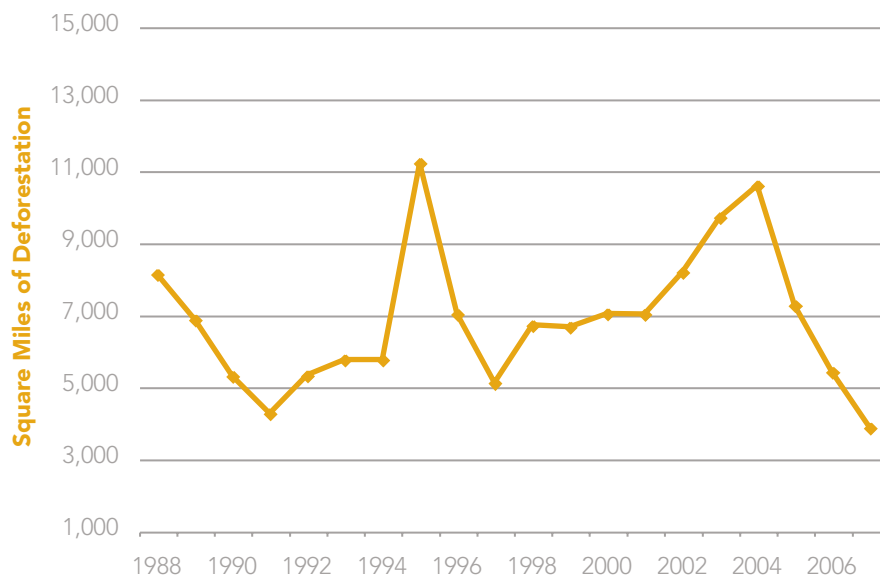
The chief point of Grainger's review is not to challenge categorically the conventional wisdom about tropical deforestation, but to direct our attention once again to the inadequacy of our data sets and analytical techniques. Despite three decades' worth of satellite imagery, many of our land assessments on the global scale are still done using low-resolution images with a high margin of error. Studies performed using high-resolution imagery often find statistically significant differences in forested area and land condition—often less alarming than the general numbers. Too many conclusions are based on "expert judgment," always prone to the errors and biases of conventional-wisdom groupthink and activist anecdotes. Grainger concludes:

Our analysis does not prove that tropical forest decline is not happening, merely that it is difficult to demonstrate it convincingly using available tropical forest area data, despite the dedication of all who collected them. Global generalizations about tropical forest trends should therefore be more cautious until better global data are obtained.

Meanwhile, one of the tropical forest areas that receives the most attention and comment—Amazonia—may be experiencing a declining deforestation rate. At the end of

2007, the Brazilian government announced that its rate of deforestation had been cut by one-fifth during the previous year (and two-thirds from peak years), marking the third straight year of declining deforestation⁵ (see Figure 1).

Figure 1: Tropical Deforestation in Brazil



SOURCE: NATIONAL INSTITUTE OF SPACE RESEARCH; WWW.MONGABAY.COM/BRAZIL.HTML

Notes:

¹ *State of the World's Forests 2007* (Rome: Food and Agriculture Organization of the United Nations, 2007).

² www.fao.org/docrep/009/a0773e/a0773e00.htm.

³ Pekka E. Kauppi, Jesse H. Ausubel, Jingyun Fang, Alexander S. Mather, Roger A. Sedjo, and Paul E. Waggoner, "Returning Forests Analyzed with the Forest Identity," *Proceedings of the National Academy of Sciences*, November 14, 2006, available at www.pnas.org/cgi/doi/10.1073/pnas.0608343103.

⁴ Alan Grainger, "Difficulties in Tracking the Long-Term Global Trend in Tropical Forest Area," *Proceedings of the National Academy of Sciences*, Vol. 105 (2008), pp. 818–823.

⁵ <http://news.bbc.co.uk/2/hi/americas/7133957.stm>.

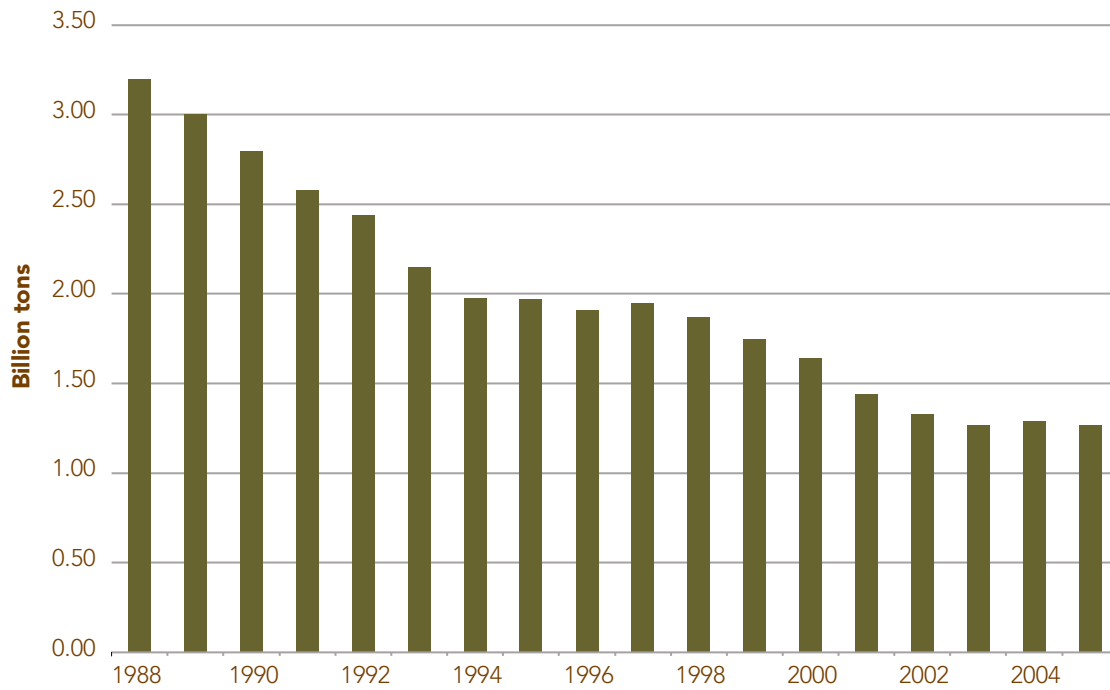


TOXIC CHEMICALS AND HEALTH RISKS

TOXICS RELEASE INVENTORY

After notching a slight increase in 2004, the EPA's Toxics Release Inventory (TRI) resumed its steady downward trend in 2005 (the most recent year reported), with a small reduction from 2004 and 2003 levels, as shown in Figure 1. This represents a 60-percent reduction from the 1988 baseline, with more than half this amount coming from the chemical and refining industries, whose total end-product output has more than doubled during the same time.

As always, the EPA emphasizes that "This information does not indicate whether (or to what degree) the public has been exposed to toxic chemicals. Therefore, no conclusions on the potential risks can be made based solely on this information (including any ranking information)."¹ (For more background on the TRI, see http://special.pacificresearch.org/pub/sab/enviro/07_enviroindex/.)

Figure 1: Toxics Release Inventory, 1988 Baseline

SOURCE: EPA

Notes:

¹ In addition, "toxic" chemicals are not all created equal, which is why a crude measure of mere "pounds" of toxics "released" is not an especially helpful measure of health or environmental risk. As the EPA notes,

Some high-volume releases of less toxic chemicals may appear to be a more serious problem than lower-volume releases of more toxic chemicals, when just the opposite may be true. For example, phosgene is toxic in smaller quantities than methanol. A comparison between these two chemicals for setting hazard priorities or estimating potential health concerns, solely on the basis of volumes released, may be misleading.

In an effort to make possible better judgments about the relative risks of different kinds of toxic chemicals, the EPA is developing the Integrated Risk Information System (IRIS) on its Web site (see www.epa.gov/ncea/iris.htm). IRIS contains the results of ongoing toxicological screens of many of the chemicals on the TRI, along with links to other studies and EPA standards for exposure to the chemical. IRIS is not easy for the non-specialist to use, but it represents a major effort to adapt the massive reporting of the TRI so as to make it a useable product for local risk assessment. Another resource is the EPA's chemical fact sheets, which are available at www.epa.gov/chemfact/.



CLIMATE CHANGE: INDICATORS AND OUTLOOK

Casual observers of environmental issues can be forgiven for thinking the matter of climate change has taken on a *Groundhog Day* quality. The year 2007 ended with two dominant news items that both had a familiar ring: 2007 was one of the 10 hottest years on record, and the Arctic ice cap retreated farther than at any time in recorded history—farther, in fact, than had been predicted by even the most alarmist climate models.

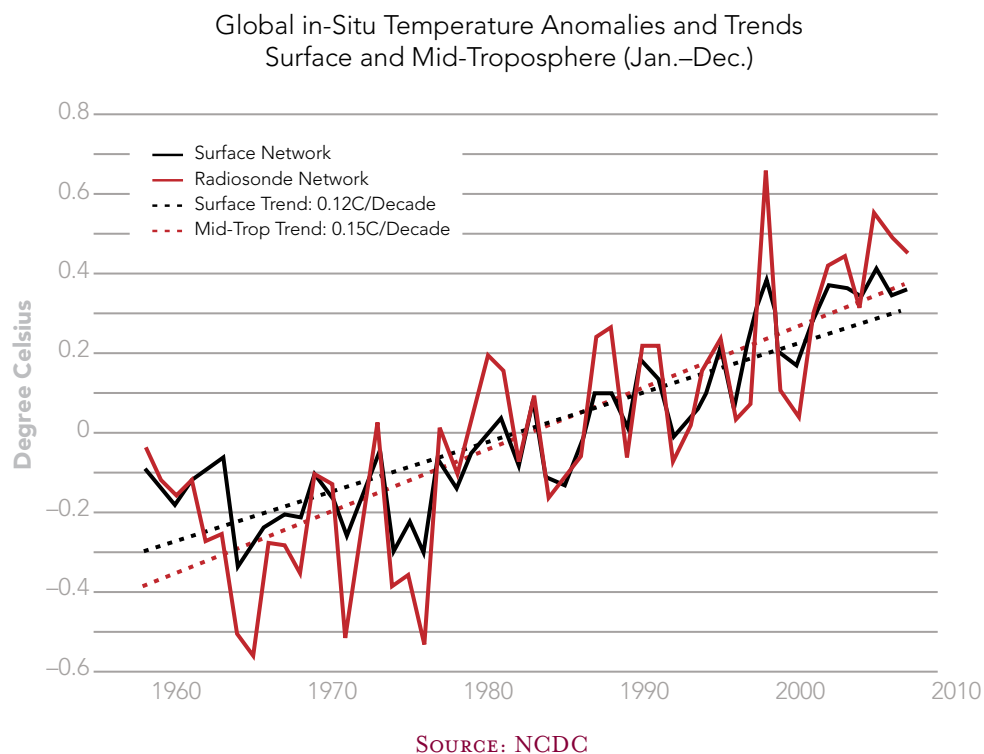
The National Climatic Data Center (NCDC, a unit of NOAA, the National Oceanic and Atmospheric Administration) announced in January 2008 that 2007 had been the fifth-warmest year since the turn of the twentieth century, with a global average temperature anomaly of 0.55 degree Celsius above the twentieth-century average. Estimating global average temperatures, both historical and current levels, is not a simple feat, and there is some variation among different reported temperature series (and between the northern and southern hemispheres). Global tem-

perature trends are derived from several methods, including both ground-based and satellite measurements, which are interpolated with estimates for areas of the earth without regular instrument readings.¹ While confidence in the global average temperature series has increased in recent years, there is still lingering controversy about its overall accuracy. (See www.climateaudit.org for a compelling critique of the ground-based temperature record.)

The debate over the minutiae of temperature measurements, however, is giving way to a debate over an anomaly within the anomalies—whether the decade-over-decade warming rate of roughly 0.15 degree Celsius is moderating. The debate offers an excellent example of how the presentation of the data sets can skew our perception of issues. Figure 1 shows the NCDC's global temperature trend since the mid-1950s, and the increase appears steady. Figure 2, also from the NCDC, shows the global temperature trend with a longer time horizon. Here the flat or slightly declining

Casual observers of environmental issues can be forgiven for thinking the matter of climate change has taken on a *Groundhog Day* quality.

Figure 1: Global Temperature Anomaly, 1957–2007

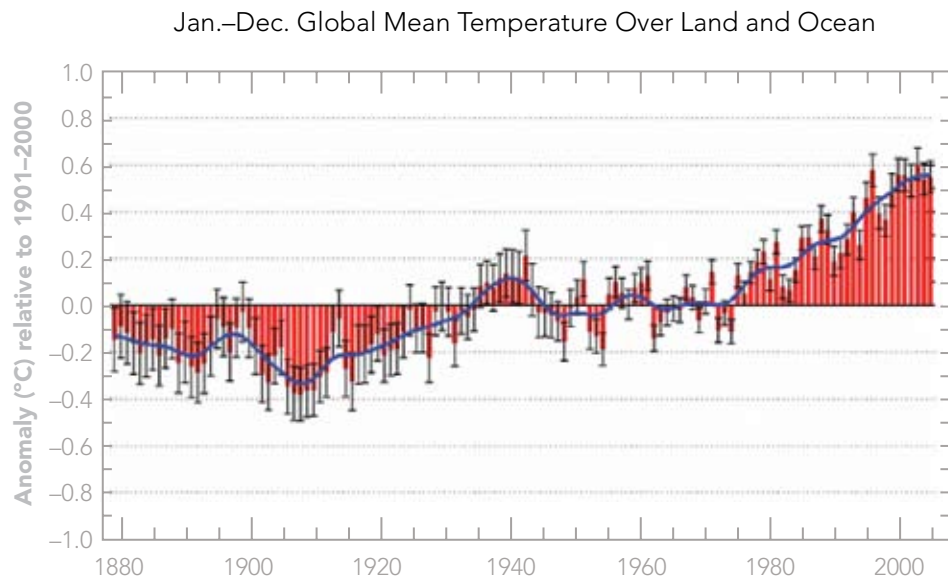


temperature trend of 1940 through about 1980 is more evident than in Figure 1, which would show a downsloping trend line if the data from 1957 through 1979 were regressed. Moreover, if one looks closely at the last decade in Figure 2, a flattening of the temperature trend is evident. The last 10 years of NCDC temperature data are displayed in Figure 3.

The data from the last decade can be interpreted in two ways. On the one hand, temperatures have been largely flat (notably so between 2002 and 2007), after two decades of steady rise totaling about 0.3 degree Celsius. A few contrarians have suggested this means global warming has halted, at least for the time being. On the other hand, it is well known that 1998—the

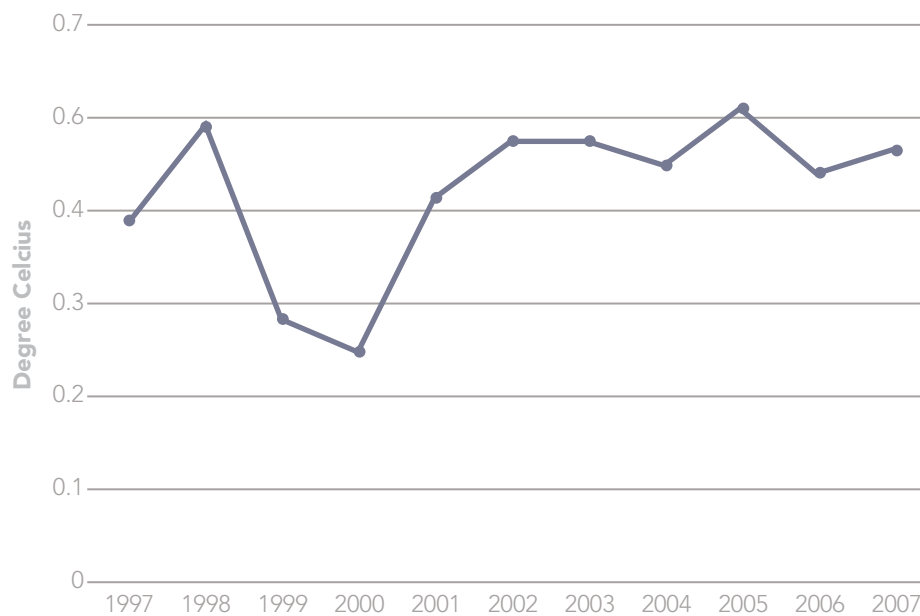


Figure 2: Global Temperature Anomaly, 1880–2007



SOURCE: NCDC

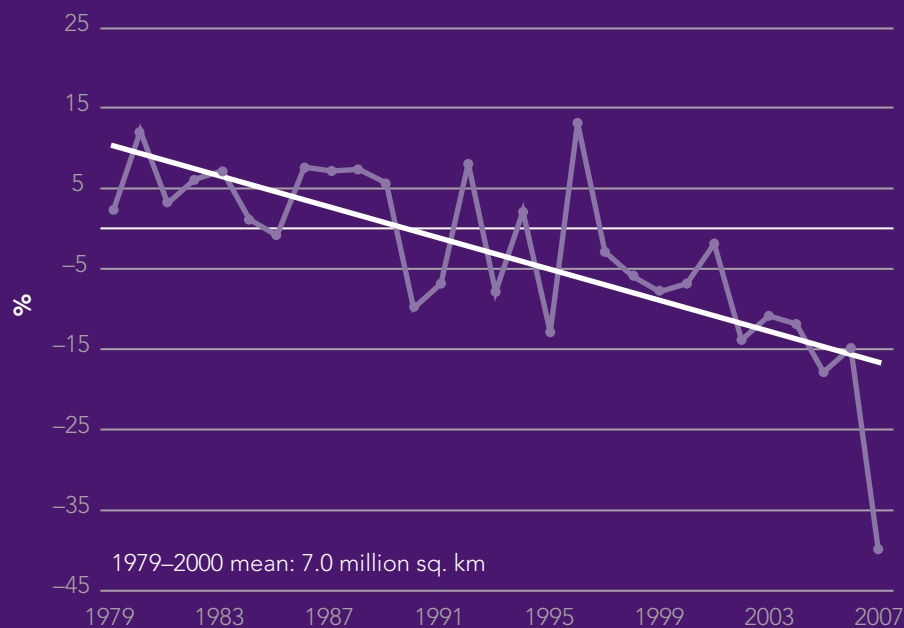
Figure 3: Global Temperature Anomaly, 1997–2007



SOURCE: NCDC

THE SECOND BIG CLIMATE-CHANGE STORY OF 2007—THE SHRIVELING ARCTIC ICE CAP—MAY ALSO TURN OUT TO BE AN ANOMALY.

Figure 4: Arctic Sea Ice Anomaly, September 2007



SOURCE: NATIONAL SNOW AND ICE DATA CENTER

hottest or second-hottest year on record over the last century—was influenced chiefly by a strong El Niño condition in the Pacific Ocean rather than greenhouse gas (GHG) levels. If one removes 1998 as an anomaly within the anomalies, then the long-term upward trend of temperatures appears to be more intact. Observers should be cautious about drawing firm conclusions from the last decade's data. It is worth noting in passing, however, that Britain's Hadley Centre, one of the pre-eminent climate-

change research institutions, has predicted that 2008 will be a cooler year. If the cooling continues, in a few more years someone is going to have some "splainin'" to do.

The second big climate-change story of 2007—the shriveling Arctic ice cap—may also turn out to be an anomaly. The extent and rapidity of the Arctic Sea ice-cap retreat last summer generated countless headlines and alarming quotations from scientists. ANALYSTS SEE "SIMPLY INCREDIBLE"

SHRINKING OF FLOATING ICE IN THE ARCTIC, the *New York Times* reported in August. Then in October, it led with the headline ARCTIC MELT UNNERVES THE EXPERTS, just in case we didn't get the message the first time. The Arctic Sea ice retreat was well beyond what any climate model had predicted, and it was said that the Arctic could be completely ice-free in the summer as soon as 2030, down from about 2070 in previous estimates. The dramatic retreat of sea ice as of September 2007 is displayed in Figure 4.² If anyone still needed proof of GHG-induced global warming, this was it.

Except maybe it wasn't. A major article published in *Nature* in January 2008 cast significant doubt on the standard account of "Arctic amplification," i.e., the well-known fact that warming in the Arctic was twice as high as the global average warming of roughly 0.8 degree Celsius over the twentieth century. The warming was attributed to "feedback loops," especially the increase in "albedo" (the additional amount of energy absorbed from the sun by darker surfaces, such as open ocean water, rather than reflective ice). In a complicated article, "Vertical Structure of Recent Arctic Warming," five scientists at the University of Stockholm noted a number of anomalies in the pattern of warming in the Arctic atmosphere, and ruled out GHG-induced amplifying feedbacks as the cause of Arctic warming. The authors instead identify changing wind patterns at high altitude as the chief driver of recent Arctic warming. "Our results do

not imply," the authors are careful to hedge, "that studies based on models forced by anticipated future CO₂ levels are misleading when they point to the importance of snow and ice feedbacks. . . . Much of the present warming, however, appears to be linked to other processes, such as atmospheric energy transports."³ Late January also brought news that Arctic Sea ice was not only re-forming at a record pace during the coldest January in several decades, but was building up thicker than normal.

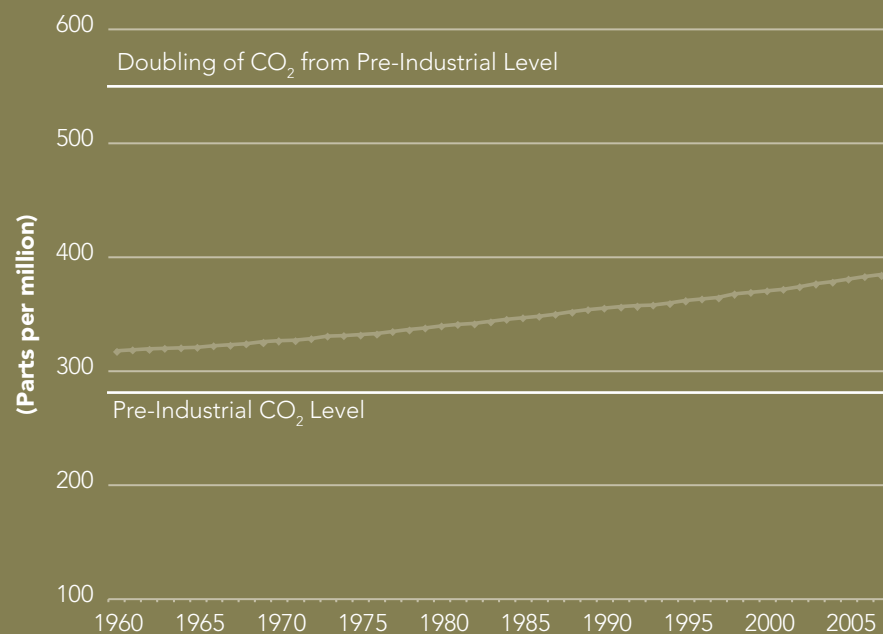
Meanwhile, heavy winter snowfall in Europe led to the early opening of many ski resorts in the Alps, which had opened late during last year's warm winter. In the western United States heavy snowfall has led many ski areas to announce plans to stay open later into the spring—as late as the first week in May for some resorts. As for Antarctica and Greenland, a flurry of new studies in peer-reviewed scientific literature presented conflicting and contradictory findings on whether Antarctic and Greenland ice is growing thicker, thinner, or staying the same.

CLIMATE POLICY INDICATORS

Though scientists and commentators consider nearly everything an indicator of climate change, since the 12th edition of this report we have identified three main *policy-relevant* indicators for tracking the issue. They are: ambient global GHG levels (principally carbon dioxide and methane), GHG emissions, and GHG intensity (i.e.,



Figure 5: Atmospheric CO₂ Concentration (Parts per Million)



SOURCE: MAUNA LOA OBSERVATORY

the amount of GHG emitted per dollar of GDP). This latter metric is arguably the most important for policy purposes, as it is a measure of the change in energy efficiency relative to economic growth. It is more useful in comparing relative efforts internationally than is the Kyoto framework of emissions relative to the 1990 baseline. The ultimate goal of sensible climate policy will be to nudge the rate at which GHG emissions intensity improves *faster* than the average rate of economic growth.

Figures 5–9 display measures for these metrics, from which several observations emerge. Figure 5 displays the trend in global CO₂ concentrations in the atmosphere, taken from the monitoring series of the Mauna Loa Observatory in Hawaii. This time series is often shown on a narrow x-axis scale, such that the increase in CO₂ appears steep and rapid—“alarming”

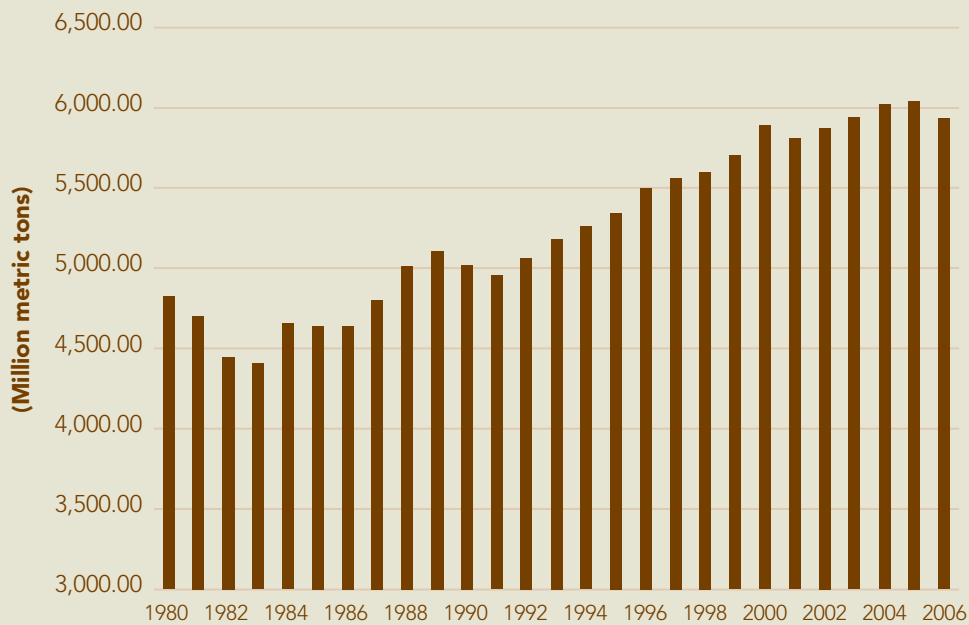
even. (Sometimes very long-term CO₂ levels are depicted on a logarithmic x-axis scale that produces even more dramatic—and misleading—imagery.) Here the trend is displayed on a wider x-axis scale with two benchmarks to note: the pre-industrial level of atmospheric CO₂, and the level representing a doubling of CO₂ (about 550 ppm). That level has become the arbitrary target for carbon stabilization at some future point, beyond which it is presumed—though far from proven—that dramatic harm to the planet will occur.

Figure 5 makes evident an important fact typically left out of discussion: It has taken 200 years to go a little more than one-third of the way toward a doubling of CO₂ levels in the atmosphere. Moreover, the increase has been steady, rising an average of 0.41 percent a year since close monitoring began in the late 1950s, or about 1.5 parts per million per year. The rate has increased only slightly since global economic growth started accelerating in the 1980s. At these rates, it will be well into the twenty-second century before the CO₂ level reaches twice its pre-industrial level. Most projections of high temperature increase from greenhouse gases assume that this trend will break sharply upward very soon—that the rate at which CO₂ is accumulating in the atmosphere will more than double from the long-term historical trend. Despite the common-sense case that the surging emissions from the developing world—especially China and India, which together are projected to exceed emissions from the currently developed nations within the next few years—might push up the rate of CO₂ accumulation in the atmosphere, there are reasons to doubt this will be so.

Figure 6 displays U.S. CO₂ emissions from 1980 to 2006, while Figure 7 displays the year-over-year change from 1991 to 2006. Both figures demonstrate the moderating trend in CO₂ emissions over the last decade. CO₂ emissions rose 13.7 percent during the eight years of the Clinton administration, but they grew only 2.2 percent during the first six years of the Bush administration, culminating in an absolute *decline* of 1.5 percent in 2006—the first time GHG emissions have ever declined in a non-recessionary year.

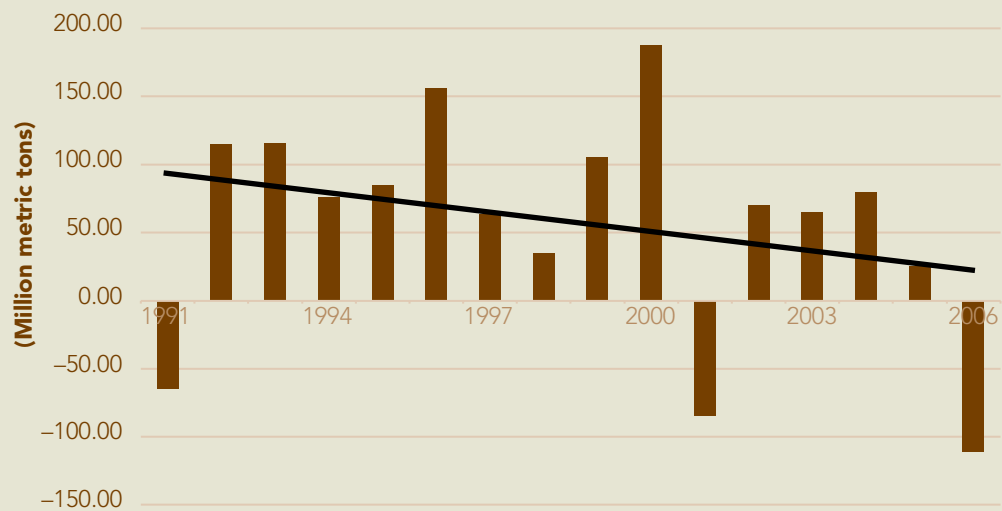
The next level of refinement in this analysis is to consider measures of GHG intensity; that is, the amount of greenhouse gases emitted per dollar of economic output. The common but mistaken view is that the United States is vastly less energy efficient than

Figure 6: U.S. CO₂ Emissions, 1980–2006

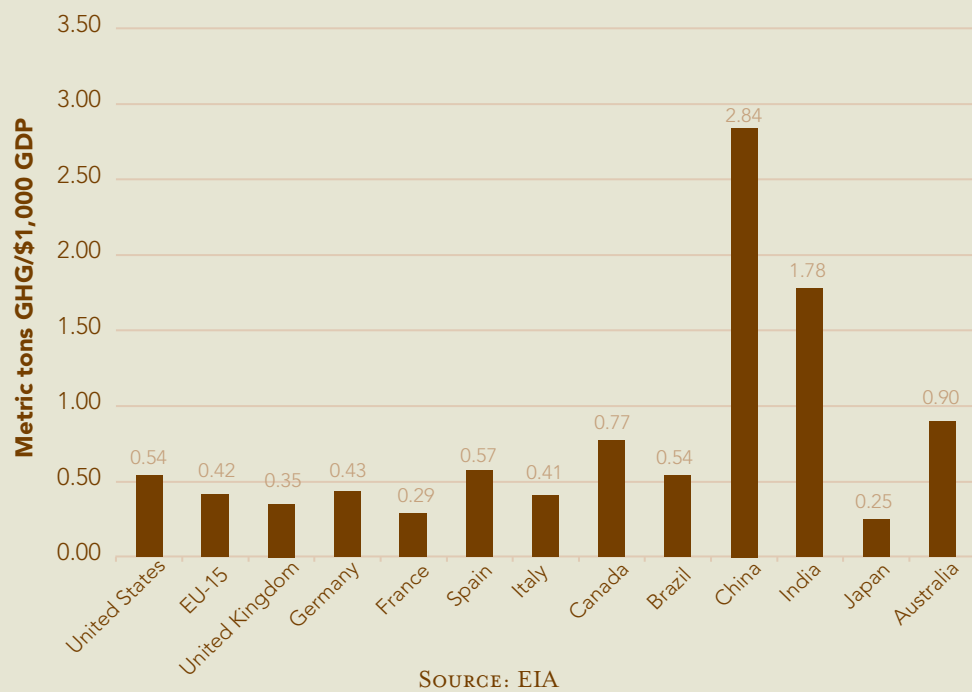
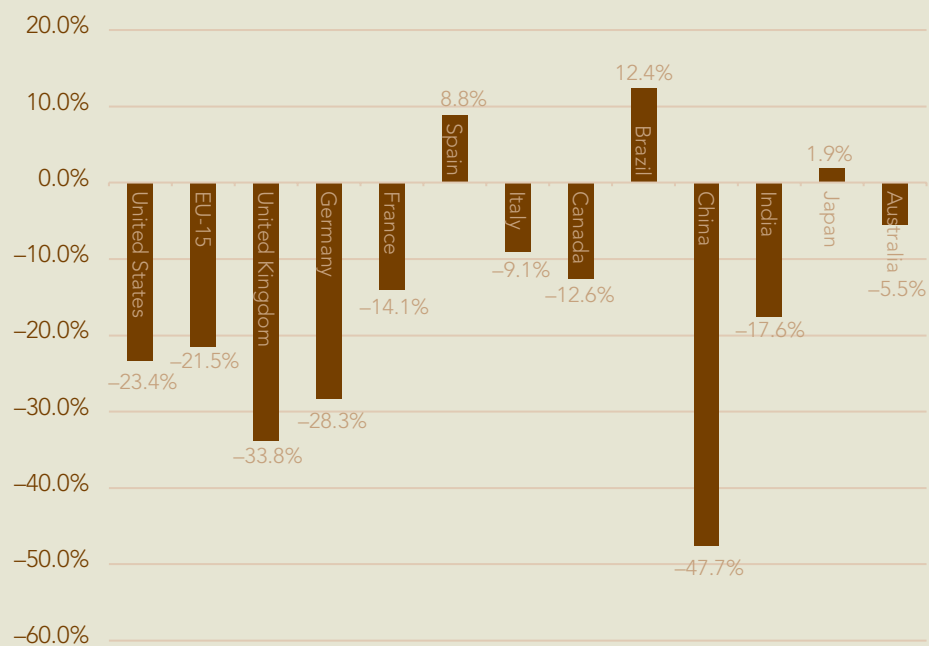


SOURCE: ENERGY INFORMATION ADMINISTRATION [EIA],
"EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES, 2006"

Figure 7: Annual Change in U.S. CO₂ Emissions, 1991–2006



SOURCE: EIA, "EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES, 2006"

Figure 8: Greenhouse Gas Emissions Intensity, 2005**Figure 9:** Change in GHG Intensity, 1991–2005



European nations. In fact, when measured on an output-adjusted basis, American GHG intensity is only slightly higher than those of the wealthy EU-15 nations, as shown in Figure 8. (This aspect of the matter will be discussed in detail in the next section.) Japan is actually the emissions-intensity champion among the G-8 nations.

Going forward, the most useful metric to watch will be the rate of change in GHG intensity. Here, the record of the United States is enviable. Since 1991, the year after the Kyoto Protocol benchmark, U.S. GHG intensity has declined by 23.4 percent, compared with 21.5 percent for the EU-15 (see Figure 9). Over the last five years it appears the improvement in U.S. GHG intensity has been accelerating. The improvements in GHG intensity that Germany and Britain experienced are due partly to one-time extraordinary circumstances. In the case of Britain, decisions made before 1990 to make a transition from coal to natural gas for electricity generation account for much of the improvement, while Germany owes much of its success to shutting down old, inefficient facilities in the former East Germany after unification in 1990. By contrast, the comparable U.S. performance represents continuous improvements in efficiency.

ENERGY AND GHG EMISSION INTENSITY: THE UNITED STATES AND THE WORLD COMPARED

The United States came out poorly in the World Economic Forum's latest *Environmental Performance Index*. As mentioned in the preface, the United States was in 28th place in the 2005 iteration of this ranking. However, it fell to 39th place in the 2008 EPI. Notably, the United States ranks last among the G-8 industrialized nations, and third-to-last among all advanced wealthy nations, beating only Australia and the Netherlands in the EPI rankings. It was this recent release that yielded the *New York Times* headline U.S. GIVEN POOR MARKS ON THE ENVIRONMENT.

The EPI has many useful and important features. The report's most valuable affirmation is the link between economic growth and environmental quality. "Wealth correlates highly with EPI scores and particularly with environmental health results," the EPI notes. The



EPI's policy summary reiterates several essential points that receive insufficient attention in environmental discourse:

Environmental decision making can and should be made more data-driven and rigorous. A more fact-based and empirical approach to policymaking promises systematically better results. . . . To address [data] gaps, policy-makers should invest in collecting additional data and tracking a core set of indicators over time. They must also set clear policy targets and incorporate indicators and reporting into policy formation, and shift toward more analytically rigorous environmental protection efforts at the global, regional, national, state/provincial, local, and corporate scales . . .

The absence of broadly-collected and methodologically-consistent indicators for even basic concerns such as water quality—and the complete lack of time-series data for most countries—hampers efforts to shift pollution control and natural resource management onto more empirical foundations.⁴

The EPI concedes that lack of data makes it impossible to consider numerous relevant environmental issues in constructing an international performance ranking.⁵

Energy use and GHG emissions are areas where data are easy to come by or estimate confidently from resource use models. It is on this metric that the United States fares poorly in the EPI's methodology, because the EPI assigns one-quarter of its weighting to three climate-change metrics. Chiefly because of this weighting, the United States finishes last among the G-8 nations, and well down the list of advanced or wealthy nations, behind 12 of the core nations of the EU-15. (Even Brazil ranks ahead of the United States on the EPI. See Table 1.)

This heavy weighting of climate-change metrics is vulnerable to two criticisms. First, weighting any index requires some arbitrary choices and the inclusion of data sets that may not reflect true differences across nations. Some individual metrics outside the areas

Table 1: 2008 EPI Ranking

EPI Rank		EPI Score
1	Switzerland	95.5
2	Sweden	93.1
3	Norway	93.1
4	Finland	91.4
6	Austria	89.4
10	France	87.8
12	Canada	86.6
13	Germany	86.3
14	United Kingdom	86.3
18	Portugal	85.8
21	Japan	84.5
24	Italy	84.2
25	Denmark	84
28	Russia	83.9
30	Spain	83.1
31	Luxembourg	83.1
34	Ireland	82.7
35	Brazil	82.7
39	United States	81
44	Greece	80.2
46	Australia	79.8
47	Mexico	79.8
51	South Korea	79.4
55	Netherlands	78.7
57	Belgium	78.4
102	Indonesia	66.2
105	China	65.1
120	India	60.3

SOURCE: EPI 2008

of climate change and energy use illustrate the problems inherent in any such international comparison. For example, on the EPI's measure of "ecosystem vitality," Russia scores higher than the United States, which seems implausible given the environmental ruin from decades of Soviet rule. On this single metric, the United States ranks 107th, far behind a number of African nations whose environmental records and protection regimes are at the very least dubious (Congo ranks 4th; Malawi, 8th; Mozambique, 17th; Uganda, 20th; and Rwanda, 32nd, for example).

Second, even within less subjective energy and climate measures, several important qualifications are left out of the calculation, to the disadvantage of the United States. One way of understanding the arbitrariness of the EPI—or any similarly constructed performance index—is to select, even at random, a different set of metrics. The World Bank's *Little Green Data Book* for 2007 offers one approach. The World Bank's metrics include, for example, measures of fertilizer use, amount of land area protected for conservation purposes, an index of biodiversity benefits, energy used per dollar of economic output, an estimate of the economic damage of particulate air pollution levels, growth in CO₂ emissions from 1990 to 2003, and the proportion of a nation's freshwater resources that are consumed. Each of these metrics is susceptible to a number of qualifications, criticisms, and weaknesses, but as macro measures they are at least as suggestive as the similar measures used in the EPI.

While the United States ranks last among the G-8 on the EPI, in none of the World Bank categories does the United States rank at the bottom (see Table 2).

A closer look at the World Bank's "Global Environmental Facility Benefits Index for Biodiversity" reveals the problem analysts face in constructing meaningful comparative indices of environmental quality. The World Bank's index for biodiversity is described as "a composite index of relative biodiversity potential for each country . . . based on the species represented in each country, their threat status, and the diversity of habitat types in each country. The index has been normalized so that values run from 0 (no biodiversity potential) to 100 (maximum biodiversity potential)." This opaque methodology is probably at least as susceptible to criticism as the EPI's biodiversity metric, but because they both use a 0–100 scale the sharp contrast between the World Bank's and EPI's national scorings is a useful illustration of the limitations of this kind of metadata exercise. Table 3 displays the EPI and World Bank biodiversity scores. The contrast between the two scoring systems suggests that we are far from reaching a consensus on the best methodology for judging biodiversity.

The United States is the world's leading emitter of greenhouse gases on a per-capita basis.⁶ In 2004, the most recent year for which complete international data are available for comparison, the United States emitted 19.9 tons of CO₂ per capita,

Table 2: U.S. Rankings in World Bank *Little Green Data Book* (2007)

U.S. G-8 Rank for:

EPI	8
Fertilizer Use	3
Biodiversity Potential	1
Protected Land Area	3
Energy Use per \$ of GDP	3
Per-Capita Energy Use	7
Particulate Damage	6
Freshwater Utilization	4
CO ₂ Emissions Growth, 1990–2003	7

compared to the G-8 average (excluding the United States) of 10.1 tons. Americans also use substantially more energy than Europeans on a per-capita basis, whether measured in oil equivalent (one of the World Bank's measures) or in kilowatt-hours (kWh) of electricity. Americans consume 7,920 kg oil equivalent per capita, compared to the European G-8 average of 4,060. Per-capita electricity consumption in the United States is 13,351 kWh, compared to a European G-8 average of 6,483.

This comparison requires a closer look. Even on the World Bank's metric of energy use per dollar of economic output the United States does not finish last, as it does in the EPI. As Table 4 shows, the United States ranks 6th among the G-8 nations, ahead of



U.S. greenhouse-gas emissions in the industrial sector are actually down 1.7 percent since 1990, and almost 5 percent since 1970.

Table 3: EPI and World Bank Biodiversity Scores Compared

	EPI Biodiversity Rank	EPI Biodiversity Score	World Bank Biodiversity Score
Central African Republic	1	100	1.7
Botswana	2	100	1.5
Saudi Arabia	5	95.5	3.4
Congo	6	93.4	3.4
Tanzania	13	87.2	15.1
Russia	20	79.2	37.1
Ethiopia	35	71.2	8.5
United States	40	65.3	90.3

only Canada and Russia.⁷ Among a wider pool of industrialized countries, the United States has an energy-to-output ratio superior to those of Sweden and Finland, both of which rank considerably higher than the United States on the EPI. The lower ratio of energy to GDP for these northern nations, as for Canada, probably owes much to the harsh winter climate, where more energy is necessary for basic heat.

Three important differences between the United States and our G-8 competitors that account for our higher GHG emissions need to be more adequately

recognized and factored into analysis of these issues. First, one reason for higher U.S. emissions is that more of our energy infrastructure is based on fossil fuels, though with the notable exceptions of France and Canada, not vastly more. (In fact, Britain and Italy generate a higher proportion of their electricity from fossil fuels than the United States.) Table 5 displays the proportion of electricity generated with fossil fuels in the G-8 nations.

Second, America's per-capita emissions are higher than Europe's in part because the American standard of living is considerably

higher than the European standard of living. U.S. per-capita income is one-fourth higher than the average for the European G-8 nations (Russia excluded); the World Bank's *Little Green Data Book* places the United States' 2005 per-capita income at \$43,560, while the six other main G-8 members are at an average of \$34,833. If U.S. GDP were one-fourth lower, our GHG emissions per capita would be about 15 or 16 tons per person, instead of nearly 20.

Third, even if U.S. GDP were one-quarter lower, U.S. per-capita emissions would still be substantially higher than the G-8 average because of larger homes and longer transportation distances in the United States. The average dwelling unit in the United States is about 2,400 square feet today (up from 1,500 square feet in 1970), while the average dwelling unit in Western Europe is about half the current U.S. size (800 square feet in Italy, 1,300 square feet in France, and 1,200 square feet in Germany, for example.⁸) On account of Europe's milder summer climate, most homes are not air-conditioned. Over 60 percent of American housing units are air-conditioned, and in recently constructed housing, the number approaches 90 percent, while fewer than 10 percent of European housing units have air conditioning. Only 27 percent of

Table 4: Energy Use per \$ of GDP

	Kg Oil Equivalent per \$ of GDP
Russia	2.0
Canada	3.4
United States	4.6
France	5.9
Germany	6.2
Japan	6.4
United Kingdom	7.3
Italy	8.2
EU-15 average	6.6

SOURCE: WORLD BANK, *Little Green Data Book*, 2007

Table 5: Percentage of Electricity
Generated from Fossil Fuels, 2004

Italy	77.3
United Kingdom	75.9
United States	71.4
Russia	65.3
Germany	62.3
Japan	59.4
Canada	26.2
France	9.3

SOURCE: WORLD BANK, *Little Green Data Book*, 2007

commercial buildings in Europe have air conditioning, compared with 80 percent in the United States.⁹

One way of appreciating the difference between emissions by the United States and the other G-8 countries is to look at energy use just in the industrial sector of the economy. U.S. GHG emissions in the industrial sector are actually down 1.7 percent since 1990, and almost 5 percent since 1970. Most of the growth in U.S. GHG emissions has come from the residential sector (up 25 percent since 1990) and the transportation sector (also up 25 percent since 1990). Moreover, U.S. energy use in the industrial sector is not far out of line with European averages. Table 6 displays industrial-sector output for the year 2004, and shows the United States lagging behind Japan and the United Kingdom, coming close to France, and outperforming Italy, the Netherlands, and both Sweden and Finland—all nations that rank higher than the United States on the EPI.

To be sure, different mixes of electricity generation go a long way toward explaining lower per-capita GHG emissions in nations such as France, which generates 80 percent of its electricity with carbon-free nuclear power. One important sector where there is less difference in per-unit CO₂ emissions is transportation. Critics of the United States usually note our low-mileage auto fleet and lack of public transit compared with Western Europe. However, the

Table 6: Industrial Output per Ton of Oil Equivalent (TOE), 2004

	Industrial Output Per TOE, 2000 \$ (PPP)
Japan	15,826
United Kingdom	11,426
Germany	9,075
France	8,179
Austria	7,875
United States	7,597
Italy	7,118
Netherlands	6,426
Greece	6,141
Spain	5,791
Sweden	5,647
Belgium	5,066
Portugal	4,586
Canada	4,191
Luxembourg	3,720
Finland	3,090

SOURCE: AUTHOR'S CALCULATIONS FROM
INTERNATIONAL ENERGY AGENCY DATA

United States is a much larger, less densely populated area than Western Europe.

Table 7 compares the continental United States and the EU-15 in land area, population density, kilometers of roads and rail lines, transportation density (i.e., kilometers of roads and rail lines per thousand square kilometers), and energy

The U.S. may have been the only industrialized nation that reduced its greenhouse-gas emissions in 2006.

Table 7: Population and Transportation Density Measures

	Population	Land Area (Km ²)	Population Density	Kilometers of Roads	Kilometers of Rail Lines	Road+ Rail (Km)	Road/Rail Density (Km/1,000 Km ²)	Transport Energy Consumption (1,000 TOE)
United States	303,000,000	7,415,756	40.9	153,956	92,523	246,479	33.2	711,862
EU-15	372,939,000	3,367,154	110.8	45,264	150,476	195,740	58.1	324,417

SOURCE: *Panorama of Transport*, 2007

consumption by road and rail transportation. The United States has to move people and goods much longer distances than do Western European nations, and as a result the United States uses more than twice as much energy in its transportation sector. The European Commission (EC) has taken note of this fact, reporting in its Eurostat *Panorama of Transport* report for 2007 that the United States performed 5,233 billion ton-kilometers of freight transport in 2003 (the last year for which the EC has complete data), while the comparable figure for the entire EU-25 was only 2,184 billion ton-kilometers. "Measured by tonne-kilometres, the EU-25 performs less transport (restricted to inland modes) than the United States," the EC concludes.¹⁰ U.S. rail transport is six times the amount of the EU-25 (2,341 billion ton-miles for the United

States versus 364 billion ton-miles for the EU-25). The United States actually ships a larger proportion of its freight by rail than does Europe.¹¹ It is hard to tell whether or not, on a per-kilometer basis, the United States has higher GHG emissions than Europe, because diesel fuel powers more of the U.S. rail infrastructure, while more of Europe's rail grid is electrified.

If these differences in standard of living and transportation density were normalized, America's per-capita GHG emissions would not be far different from Western Europe's. And here lies the main paradox of the misperception on this issue: It is precisely *because* the United States is highly energy efficient that we are able to afford and consume more energy than European nations on a per-capita basis. One obvious implication of this analysis is that the



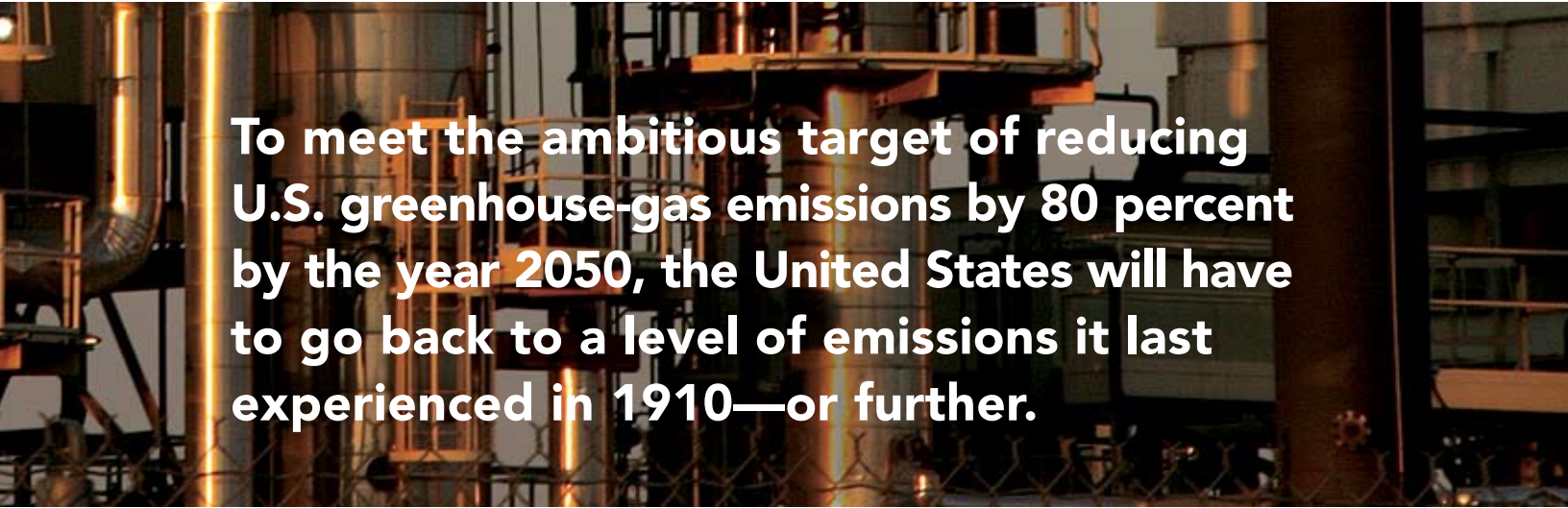
United States cannot currently achieve European-level GHG emissions unless it is prepared to reduce American output and lower the nation's standard of living.

The consistent improvement in America's energy efficiency is an untold and underappreciated long-term story. The United States has the best GHG record among the major industrial nations over the last decade, and stacks up very well when the statistics are properly compared. The U.S. energy story is far from over. In fact, as mentioned previously, some evidence suggests the United States is currently outperforming Europe in reducing energy intensity and greenhouse gases. *It is likely that the United States is the only industrialized nation where GHG emissions fell in 2006.* (Emissions data for other nations for 2006 are not yet available.)

WHAT DO OUR AMBITIOUS TARGETS MEAN IN REAL TERMS?

At first glance the reduction in U.S. GHG emissions last year gives encouragement to the campaign for major reductions in GHG emissions over the next generation or two. Former Vice President Al Gore, along with nearly every one of the Democratic presidential candidates in this election cycle, has called for an 80-percent reduction from 1990 levels in U.S. CO₂ emissions from fossil fuels by the year 2050. (On the GOP side, John McCain is not far behind, calling for a 65-percent reduction by the year 2050.) Given the nation's dramatic success in reducing other forms of air pollution over a similarly long time horizon, this target might not seem unreasonable or unobtainable. Public discourse is filled with optimistic talk of alternative and renewable energy sources that will enable us to reach this ambitious goal.

A closer look at this target, however, reveals some sobering—one is tempted to say, *inconvenient*—truths about energy and CO₂ emissions. First, start with current U.S. CO₂ emissions from fossil fuels. In 2006, the United States emitted 5,890.3 million metric tons (MMT) of CO₂. This translates to 19.4 tons per capita. An 80-percent reduction from 1990 levels would require that the United States emit no more than 1,002.3 MMT of CO₂ by the year 2050.



To meet the ambitious target of reducing U.S. greenhouse-gas emissions by 80 percent by the year 2050, the United States will have to go back to a level of emissions it last experienced in 1910—or further.

The first threshold question is: When were U.S. CO₂ emissions last at that level? From U.S. Department of Energy historical statistics on energy consumption, it is possible to estimate that the United States emitted CO₂ at that level in the year 1910, when the nation's population was only 92 million, when per-capita income (in 2007 dollars) was only \$5,964, and total GDP (also in 2007 dollars) was about \$551 billion—about one-twentieth the size of the U.S. economy today (see Table 8). One observation immediately jumps out from Table 8—the significant and sustained *improvement* in U.S. energy efficiency between 1910 and 2006. While the economy has grown more than 20-fold in real terms since 1910, fossil-fuel energy consumption grew only sixfold, and per-capita CO₂ emissions less than doubled, from 10.9 tons to 19.4 tons. This is not the profile of a nation that is profligate with energy.

Table 8: U.S. CO₂ Emissions: Current Level and 1910 Level (80% Reduction)

	2006	1910
U.S. CO ₂ Emissions from Fossil Fuels (MMT)	5,890.3	1,002.3
U.S. GDP (Billion 2007 \$)	13,244	551
Per-Capita Income (2007 \$)	43,560	5,964
Population	303,000,000	92,228,000
Fossil Fuel Energy (BTU Quads)	87.760	14.261
Per-Capita CO ₂ Emissions (Tons)	19.4	10.9

However, by the year 2050, the United States is expected to have a population of 420 million, according to Census Bureau projections—more than four times the population of 1910. To reach the 80-percent reduction target, per-capita CO₂ emissions will have to be no more than 2.4 tons per person—only one-quarter the level of per-capita emissions in 1910.

This suggests a second threshold question: When did the United States last experience per-capita CO₂ emissions of only 2.4 tons? From the limited historical data available, it appears the answer to this query is 1875.¹² In 1875, the nation's GDP (in 2007 dollars) was \$143.2 billion, per-capita income (in 2007 dollars) was \$3,180, and the population was only 45 million. And it is possible that per-capita CO₂ emissions were never this low even before the widespread use of fossil fuel, as wood burning by Americans in the nineteenth century may have produced more than 2.4 tons of CO₂ per capita. Much depends on the emissions co-efficient for wood burning, and how, since wood is biomass rather than a fossil fuel, re-growth of forestland is accounted for. In 1875, twice as much energy was generated from burning wood as from fossil fuels.

Table 9 displays some of the implications of the 80-percent target: the shuttering or replacement of virtually the entire fossil-fuel energy infrastructure of the United States.

Table 9: Energy Production from Fossil Fuels (Coal, Natural Gas, and Oil)

Year	1875	1910	2006
Fossil Fuel Energy (BTU Quads)	1.45	14.26	84.76

SOURCE: EIA

DO ANY NATIONS CURRENTLY HAVE PER-CAPITA CO₂ EMISSIONS AT THE U.S. TARGET FOR 2050?

To dramatize how extreme an 80-percent reduction in U.S. CO₂ emissions by the year 2050 would be, consider the following comparisons:

- Are there any modern industrialized nations whose CO₂ emissions come close to the putative target for 2050? The wealthy nations with the lowest CO₂ emissions per capita are France and Switzerland. France famously generates about 80 percent of its

electricity with carbon-free nuclear power, while Switzerland generates most of its electricity with carbon-free nuclear and hydro power. Yet France's per-capita CO₂ emissions are 6.59 tons, and Switzerland's 6.13 tons—both more than twice the level the United States must achieve to reach the reduction target of 80 percent.

- Table 10 displays nations that currently have per-capita emissions close to the target 2050 level and the level the United States had in 1875.

Table 10: Per-Capita CO₂ Emissions

	Per-Capita CO₂ Emissions	Per-Capita Income (2006 \$)	CO₂ Emissions Intensity
Grenada	2.1	3,860	0.56
Belize	2.9	3,570	0.87
Mauritius	2.6	5,250	0.75
Syria	2.7	1,380	1.99
Argentina	3.4	4,470	0.47
Botswana	2.3	5,590	0.60
Jordan	3.3	2,460	1.65
Brazil	1.6	3,550	0.54
France	6.6	34,600	0.29
United States, 2006	19.4	43,560	0.54
United States, 1875	2.4	3,178	NA

SOURCE: EIA, WORLD BANK, AND AUTHOR'S CALCULATIONS

Table 10 permits several observations:

- All the nations that currently emit at approximately the per-capita target the United States must achieve by 2050 are very poor nations—as was the United States in 1875.
- U.S. CO₂ emissions intensity compares favorably with the poor nations on this list. In fact, the United States has a higher ranking on the EPI than all of these nations, except France.

WHAT WOULD BE REQUIRED TO MAKE AN 80-PERCENT REDUCTION IN EMISSIONS?

Understanding how radical the 80-percent reduction target is requires walking patiently through the thicket of data on energy use and GHG emissions on a personal and household level. What does it mean in practical, everyday terms for individuals and households?

Begin with the current inventory of GHG emissions. The Department of Energy divides our GHG emissions inventory into four sectors of the economy: residential, commercial, industrial, and transportation. For purposes of this analysis, we limit ourselves only to CO₂ emissions, which account for nearly 90 percent of total GHG emissions and are almost entirely energy-related in origin. Table II displays the current breakdown of CO₂ emissions from each of these four sectors.

Table 11: CO₂ Emissions in 2006 by Sector (Million Metric Tons)

Sector	CO ₂ (MMT)	% of Total
Residential	1,204.2	20.4
Commercial	1,045.2	17.7
Industrial	1,650.8	28.0
Transportation	1,990.1	33.8

SOURCE: EIA

Keep in mind from the analysis in Table 8 that the 80-percent reduction target for the year 2050 will be 1,002 MMT of CO₂; think of this target as the “magic number.”

From Table II it is evident that America’s residential sector *already* exceeds the magic number by 20 percent.

Table 12 restates the current level of emissions and the level of emissions each sector will have to achieve in order to maintain the same approximate share of total emissions that it has today. By contrast, the Department of Energy, looking ahead to increased energy demand on account of population and economic growth, projects substantial *increases* in CO₂ emissions in the decades ahead. DoE projections only go through the year 2030; these projections are indicated in the fourth column of Table 12. The probable increase by the year 2050 would be about 15 percent higher if the same rate of annual increase

Table 12: Current CO₂ Emissions and 2050 Targets Compared

Sector	Current CO ₂	2050 Target	DoE 2030 Projection
Residential	1,204.2	204.9	1,509.4
Commercial	1,045.2	177.9	1,482.2
Industrial	1,650.8	280.9	1,893.3
Transportation	1,990.1	338.6	2,488.0

SOURCE: EIA AND AUTHOR'S CALCULATIONS

occurs.¹³ The distance between the 80-percent reduction target and the DoE projections for 2030 begins to suggest the gulf between idealism and reality.

IMPLICATIONS FOR HOUSEHOLD ENERGY USE

Currently America's 111 million households produce an average of 11.4 tons each of CO₂ emissions per year. These emissions come from heating, cooling, running appliances, and so forth, and do not include any emissions from driving automobiles—that aspect of the issue will be considered separately below.

In 2050, there will be between 140 million and 150 million American households, depending on population growth.¹⁴ If we are to hold residential-sector CO₂ emissions to no more than 204.9 MMT, each household can emit no more than about 1.5 tons of CO₂. To put this number in perspective, consider that, according to 2001 estimates from the DoE, the average U.S. household produces between 6.5 and 8 tons of CO₂ a year just from its consumption of electricity. (There are discrepancies in the estimates depending on which DoE study is referenced; the 2001 survey of residential energy use places the number at 6.5 tons per household; the DoE's 2006 *Emissions of Greenhouse Gases* report estimates the amount as closer to 8 tons per household.) The rest of the 11.4 tons emitted per household comes from consumption of natural gas, heating oil, and other energy sources. Table 13 displays current sources of household CO₂ emissions by major source.

Table 13: Residential CO₂ Emissions by Energy Source

	CO ₂ Emissions (MMT)	Tons Per Household
Electricity	866.0	8.09
Natural Gas	237.3	3.83
Fuel Oil, Kerosene, etc.*	100.3	3.77
Total	1,204.2	Avg: 11.4

SOURCE: EIA

* Only 21 million households make use of fuel oil, propane, or kerosene, and use less natural gas and electricity as a tradeoff; hence the third column does not sum to the average of 11.4 tons per household.

Table 13 makes clear that current consumption of natural gas (“clean” natural gas, as it is often called) *already generates CO₂ emissions greater than the household target for the year 2050*. According to DoE long-range projections, annual household consumption of natural gas is expected to increase by 400 billion cubic feet by the year 2030, which will increase natural-gas CO₂ emissions to 275 MMT—well above the 2050 target.¹⁵ The problem of household electricity use is even more daunting.

According to the DoE, the average U.S. household in 2001 (the last year for which the DoE has a detailed survey of residential energy consumption) consumed 10,656 kWh of electricity.¹⁶ The DoE further estimates that each kilowatt of electricity accounts for 1.34 pounds of CO₂ emissions under the current electricity infrastructure in the United States.¹⁷ To restrain CO₂ emissions from electricity consumption within America’s current energy infrastructure, each household would need, by 2050, to cut back its electricity consumption to just 2,468 kWh per year, and have zero emissions from natural gas or any other fossil-fuel energy source. *This is not enough electricity to run the average hot-water heater.*

Table 14 displays the electricity use and CO₂ emissions from typical major household appliances. Even using high-efficiency EnergyStar appliances and compact fluorescent light bulbs will not reduce electricity consumption enough to meet the target; a household that used appliances that consumed one-third the amount of current appliances would still emit about three tons of CO₂ per year—twice as much as the target.

If the 80-percent reduction in CO₂ emissions is to be achieved, the drastic reduction in energy consumption implied here for households will have to be matched by similar

reductions in the industrial and commercial sectors of the economy, as Table 12 makes clear.

CAN WE DEVELOP ENOUGH LOW-CARBON ELECTRICITY?

The foregoing analysis may be challenged on the ground that if the United States can reform its fossil-fuel electricity generation infrastructure, households (and industry) can continue to consume electricity at or near the current level. There is relentless advocacy of renewable energy such as solar power, wind power, even a revival of nuclear power. There is surprisingly little assessment of what needs to be achieved in the electricity sector to meet the 80-percent reduction target.

Currently the electric-power sector accounts for 2,343.9 MMT of CO₂ emissions every year—just under 40 percent of total CO₂ emissions in 2006. Table 15 displays the share of those CO₂ emissions by fuel source. If the electric-power sector is assumed to account for the same share of CO₂ emissions in the year 2050, it must be limited to no more than about 400 MMT. Keep in mind that because of our growing population and economy, the United States will need to produce about 40 percent more electricity than today. (DoE projections only go out to the year 2030; current projections for 2030 call for a 27-percent increase in electricity production, from 4 trillion kWh today to

Table 14: Average Household Electricity Consumption and CO₂ Emissions by Appliance

	kWh/ Year	CO ₂ Emissions (MMT)
Current Level	10,656	6.50
2050 Target	2,468	1.50
Refrigerator	1,239	0.75
Freezer	1,039	0.63
Central A/C	2,796	1.70
Room A/C	950	0.58
Water Heater	2,552	1.55
Other Appliances*	4,495	2.73
* Clothes Dryer	1,079	0.66
*Dishwasher	512	0.31
*Microwave	209	0.13
*TV (one)	137	0.08
*Desktop Computer	262	0.16
*Flat-Screen TV	400	0.18

SOURCE: EIA

5.1 trillion kWh in 2030. By 2050 electricity demand is likely to reach 6 trillion kWh.) To meet the demand in 2030, the DoE predicts that coal-powered electricity generation will increase by one-third, though in recent months several states, notably Kansas and Texas, have refused to permit the construction of new coal-fired power plants, calling into question the long-run prospects for the expansion of coal-fired generating capacity. But if not coal—what?

Table 15: Electric-Power Sector CO₂ Emissions by Fuel Source

Fuel	CO₂ Emissions (MMT) in 2006	DoE Projection for 2030
Coal	1,937.9	2,706.0
Natural Gas	339.5	279.0
Petroleum	54.5	47.0
Total	2,343.9	3,044.0

SOURCE: EIA

Right now natural gas, which emits about half as much CO₂ per unit of energy produced as coal (1.3 lbs per kWh for natural gas versus 2.1 lbs per kWh for coal), is the favored alternative to coal for new electricity generation. According to the DoE projections for 2030, CO₂ emissions from natural-gas electricity generation are expected to grow between now and 2015, but to decline by 2030 because of the mounting constraints on supplies of natural gas and the competition for its use in other sectors, such as home heating, chemicals, and pharmaceuticals. Total electricity output from natural gas is projected to increase with the use of more efficient combined-cycle power plants.

But even if the United States were able to overcome the supply constraints on natural gas—perhaps by allowing exploration and production of the estimated 600 trillion cubic feet of natural gas in U.S. territory currently off limits for political reasons—and even if every coal-fired power plant in existence today were replaced with a natural-gas power plant, these plants would still emit 1,138 MMT of CO₂, or 136 million tons more than the 2050 target for emissions from *all* sources. When the predicted growth of electricity demand is factored in, the problem of reaching an 80-percent reduction in CO₂ emissions becomes even more daunting. Incidentally, the cost of replacing our coal-fired capacity with natural gas, at the current construction prices for gas-fired power plants, would be more than \$1.1 trillion.

Meeting the estimated electricity demand for 2030 or 2050 with natural gas instead of coal would produce CO₂ emissions higher than today's current level. Table 16 displays the tradeoff between coal and natural gas under the DoE energy forecasts. As the table makes clear, wholesale substitution of natural gas for coal will not begin to bring the United States close to its 80-percent reduction goal by 2050.

Table 16: Projections of CO₂ Emissions with Natural-Gas Substitution for Coal

	2006	2030	2050	80% Target
CO ₂ from Coal (MMT)	1,937.9	2,706.0	3,855.2	1002.3
CO ₂ with 100% Natural-Gas Substitution (MMT)	1,138.0	1,703.5	2,386.6	1002.3

SOURCE: AUTHOR'S ESTIMATES BASED ON DOE DATA AND PROJECTIONS

One possible means of producing the bulk of the six trillion kWh of electricity the nation will need by the year 2050 with low or no CO₂ emissions is through carbon sequestration for both coal and natural gas; another is a substantial expansion of nuclear power. Carbon sequestration appears at this writing to be speculative and highly expensive. The DoE's recent decision to pull the plug on the FutureGen project, America's first significant sequestration demonstration site, is a major setback.¹⁸ Most environmentalists remain opposed to nuclear power. Moreover, its capital costs, in the absence of serious carbon constraints or a carbon tax, still make it uncompetitive with coal and natural gas. It is unlikely that renewables—wind, solar, and biomass—can ever make up more than about 20 percent of our electricity supply, even in the best case. But even if a breakthrough in sequestration, a renewal of nuclear power, and a significant improvement in the cost and effectiveness of renewables were to enable us to reduce the carbon footprint of our electricity sector, the problem of emissions from the transportation sector would remain.

PLANES, TRAINS, AND AUTOMOBILES: EMISSIONS FROM THE TRANSPORTATION SECTOR

Recall from Table 12 that the transportation sector of the American economy accounts for the largest share of the nation's CO₂ emissions—1,990.1 MMT in 2006, or 33.8 percent of total emissions. If the transportation sector is to account for the same share of total CO₂ emissions in the year 2050 that it does today, its CO₂ emissions cannot exceed 338.6 MMT—an 83-percent reduction from current levels. Today's consumption of jet fuel for air travel alone accounts for 239.5 MMT of transport-related CO₂ emissions—two-thirds of the total 2050 target.



To put the 2050 target in perspective, consider that the DoE's CO₂ emissions estimates go back only as far as 1949, when CO₂ emissions from the transportation sector were 603.3 MMT. From other historic energy-consumption tables it is possible to offer a rough estimate that the last time the United States emitted around 338 MMT of CO₂ from total transportation fuel consumption (autos, trucks, rail, and air) was between 1925 and 1930, when the U.S. population was about 120 million and there were only 23 million automobiles (1930 figures) and 3.6 million trucks. In 1930, according to historical statistics, Americans logged 206 billion vehicle-miles traveled (VMT) in their cars and trucks, and consumed 15.7 billion gallons of gasoline.¹⁹

Today there are about 242 million cars, pickup trucks, and SUVs, 82,000 buses, and four million commercial trucks on the road in the United States. This fleet logged almost three trillion VMT in 2005, with total fuel consumption of 180 billion gallons of gasoline and diesel fuel, and 1,600 MMT of CO₂ emissions.²⁰

In contrast to the 180 billion gallons of motor fuel consumed in 2006, given the CO₂ emissions coefficient (19.56 lbs per gallon of gasoline, according to the DoE, and 22.3 lbs per gallon of diesel fuel), automotive fuel consumption in the year 2050 cannot exceed about 31 billion gallons if transportation's one-third share of the 80-percent reduction target is going to be met. For *today's* auto fleet, this would mean annual consumption of no more than 125 gallons per vehicle, compared with about 725 gallons per vehicle today—an 83-percent reduction. By 2050 we can conservatively expect an additional 50 million vehicles on the road, reducing the amount of fossil fuel that can be used to just 100 gallons a year per vehicle. If we make the generous assumption that by the year 2050 the auto fleet will average 50 miles per gallon of fuel, this will mean the average driver will be able to travel only 5,000 miles a year.

Currently the average driver in America travels more than 11,000 miles a year, and VMT is steadily growing with rising incomes. Nor are current hybrid cars much of an improvement. According to most carbon-footprint models, a Toyota Prius driven 10,000 miles generates 1.8 tons of CO₂; if all the autos today matched the performance of today's Prius, CO₂ emissions would be 540 MMT—60 percent higher than the 2050 emissions-reduction target.



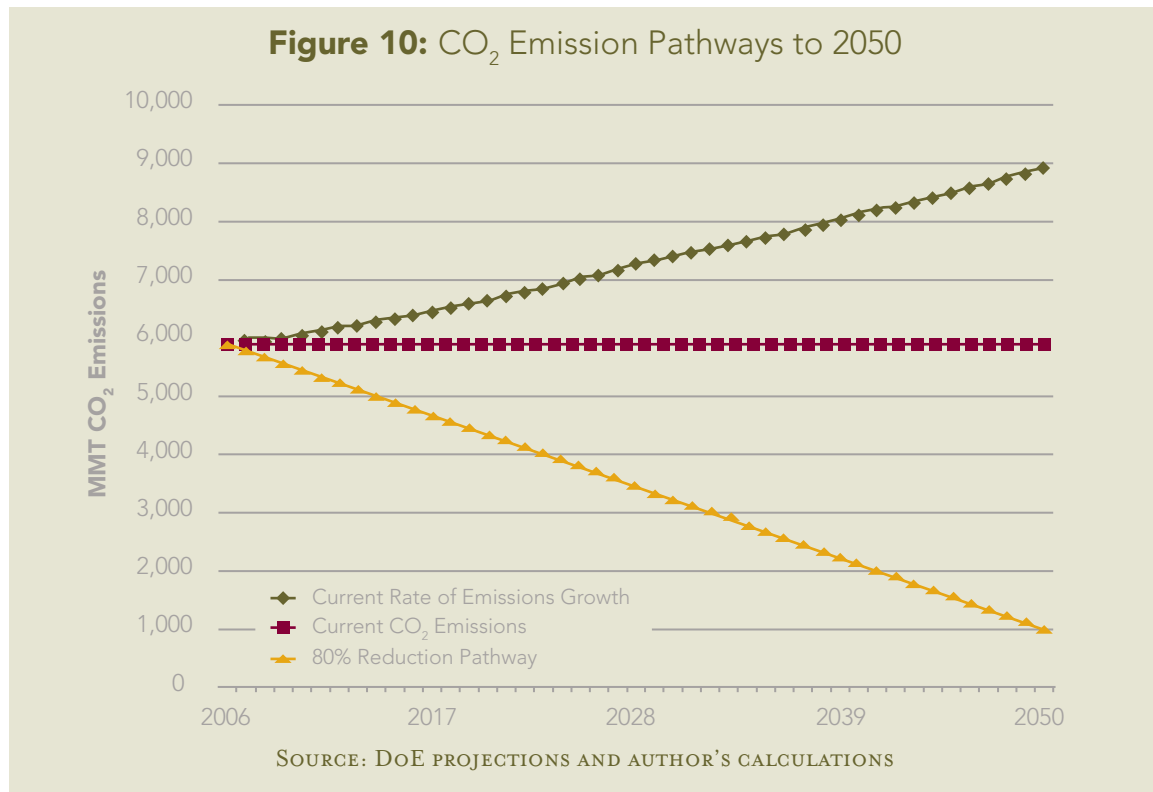
SUMMARY AND CONCLUSION

The point of the foregoing analysis is to recognize the stark unreality behind the widespread call for an 80-percent reduction in CO₂ emissions in the United States by the year 2050. The enthusiasm for that target is often justified on the general grounds that national policy should set an ambitious goal. However, the 80-percent target is the energy equivalent of John F. Kennedy making it our nation's goal to land a man on Mars instead of the moon by 1970—the technology to do so did not exist and the cost would have been prohibitive. A space program with such an unrealistic goal would have been an obvious failure, and the headlines might have read: “U.S. Falls Short/NASA Only Makes It as Far as the Moon.” Despite claims on behalf of alternative energy sources—biofuels, hydrogen, wind power, and so forth—they either do not match up to the scale of the energy required or are not cost-competitive in their current form.

Barring a revolution in energy technology, the implications of the 80-percent target for the United States include:

- Replacing virtually the entire fossil-fuel energy infrastructure of the nation, including shutting down all or nearly all coal-fired electricity-generating plants. Not even a switch to natural gas would suffice to meet the goal.
- In the absence of carbon-free electricity, American households could not use enough electricity to power their hot-water heaters without exceeding emissions targets. Forget flat-screen TVs, air conditioning, and refrigerators.
- Unless gasoline can be replaced with a carbon-free fuel, American drivers will have to switch to high-mileage cars (likely small and lightweight cars) and cut their amount of driving by more than half.

An easier way to grasp the problem is graphically, as in Figure 10, which compares current levels of CO₂ emissions with the DoE projections for CO₂ emissions extrapolated at current growth rates (the scenario typically referred to as “business as usual,” or



BAU) through 2050. The figure also maps the pathway that must be followed to achieve 80-percent reduction by the year 2050.

Another way of grasping the unreality of the 80-percent target is with reference to the “stabilization wedges” of Robert Socolow and Stephen Pacala of Princeton University, who have argued that with a supreme effort involving the adoption of seven aggressive energy strategies, the United States and the world might be able keep CO₂ emissions *flat* by the year 2050, after which time it is hoped that new energy technologies will make it possible to achieve real reductions in CO₂ emissions in the second half of the century.²¹ While this is promising as a thought experiment, because the “climate wedges” would utilize existing or feasible technologies, there are few estimates of what such a program would cost. One optimistic estimate for a U.S. program similar to Socolow–Pacala’s design comes to about \$3 trillion over the next 30 years.²²

This last point provides the most useful climate policy indicator: the price tag. Until the real cost is attached to policy goals, politicians may as well call for a 100-percent reduction in CO₂ emissions. King Canute would feel right at home in the current scene.

Notes:

- ¹ NOAA offers a useful discussion on the methodology of the matter at <http://www.ncdc.noaa.gov/oa/climate/research/anomalies/anomalies.html>.
- ² <http://icesat.gsfc.nasa.gov/>.
- ³ Rune G. Graversen, et al., "Vertical Structure of Recent Arctic Warming," *Nature*, Vol. 451 (January 3, 2008), pp. 53–56.
- ⁴ *Environmental Performance Index 2008*, p. 7.
- ⁵ The EPI identifies several important areas for which data are absent or inadequate. Those areas include: toxic exposures; several dimensions of ambient air quality; waste management (including both household and toxic waste); nuclear safety; pesticide safety and chemical exposure; wetlands loss; health of freshwater ecosystems; agricultural soil quality and erosion; and heavy metal exposure, among others.
- ⁶ Tiny and richer Luxembourg actually has higher per-capita GHG emissions than the United States, but can be considered an outlier on account of its small size and peculiar economy. Luxembourg's per-capita income is \$58,058, and its energy per use per capita is 10,481 kg oil equivalent, yielding per-capita CO₂ emissions of 22.1 tons.
- ⁷ The World Bank calculates this ratio with purchasing power parity (PPP) in 2000 dollars, using data for the year 2004. If market exchange rates (MER) are used, the outcome is more favorable to the United States. While there is considerable methodological controversy about which method (PPP v. MER) is best used for such calculations, the weight of expert opinion is on the side of PPP.
- ⁸ See http://www.unece.org/hlm/prgm/hsstat/Bulletin_06.htm, table C2.
- ⁹ <http://www.census.gov/hhes/www/housing/ahs/ahs05/ahs05.html>; <http://www.census.gov/const/C25Ann/sftotalac.pdf>; <http://www.cenerg.ensmp.fr/english/themes/syst/index.html>; <http://www.iea.org/textbase/work/2004/cooling/waide.pdf>.
- ¹⁰ *Panorama of Transport*, Eurostat Statistical Books (Luxembourg: Office for Official Publications of the European Communities, 2007), p. 68; <http://www.eurostat.gov.uk/publications/publicationlist/panorama--of--transport--2007--edition.asp>.
- ¹¹ Curiously, freight-rail volume in Europe has been declining in recent years, while it has risen in the United States.
- ¹² Sam H. Schurr and Bruce C. Netschert, with Vera F. Eliasberg, Joseph Lerner, and Hans H. Landsberg, *Energy in the American Economy, 1850–1975* (Baltimore: Johns Hopkins Press, 1960), Table VII.
- ¹³ <http://www.eia.doe.gov/oiaf/aeo/carbon.html>. Figure8_data.xls; aeotab_18.xls.
- ¹⁴ The U.S. Census Bureau projects a 2050 population of 420 million. At an average household size of 2.8 persons, there will be approximately 150 million households in the United States in 2050. Average household size continues to decline, however.
- ¹⁵ <http://www.eia.doe.gov/oiaf/forecasting.html>.
- ¹⁶ <http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html#table2>.
- ¹⁷ "Updated State-Level Greenhouse Gas Emission Coefficients for Electricity Generation, 1998–2000," EIA, April 2002, p. 4.
- ¹⁸ For background on carbon sequestration, see http://liberty.pacificresearch.org/docLib/20070202_2006_Carbon_seq.pdf.
- ¹⁹ *Historical Statistics of the United States*, Series Q 148–162 (1975 edition), p. 716.
- ²⁰ http://www.fhwa.dot.gov/policy/ohim/hs06/motor_fuel.htm.
- ²¹ S. Pacala and R. Socolow, "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies," *Science*, Vol. 305 (August 13, 2004), pp. 968–972. Pacala and Socolow were responding chiefly to Martin I. Hoffert et al., "Advanced Technology Paths to Global Climate Stability: Energy for a Greenhouse Planet," *Science*, Vol. 298 (November 1, 2002), pp. 981–987.
- ²² Reuel Shinnar and Francesco Citro, "A Road Map to U.S. Decarbonization," *Science*, Vol. 313 (September 1, 2006), pp. 1243–1244.



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